BRL-MR-3973

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MEMORANDUM REPORT BRL-MR-3973

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OUTPUT MANUAL FOR THE ARMY UNIT RESILIENCY ANALYSIS (AURA) COMPUTER SIMULATION MODEL

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MAY 1992

U.S. ARMY LABORATORY COMMAND

BALLISTIC RESEARCH LABORATORY
ABERDEEN PROVING GROUND, MARYLAND

NOTICES

# REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	May 1992	Final, September 1990–July 1991

4. TITLE AND SUBTITLE

Output Manual for the Army Unit Resiliency Analysis (AURA) Computer Simulation Model

5. FUNDING NUMBERS

PR: 1L162618AH80 ✓

6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Ballistic Research Laboratory
ATTN: SLCBR-DD-T
Aberdeen Proving Ground, MD 21005-5066

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

BRL-MR-3973

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The purpose of this report is to describe the outputs and error diagnostics generated by the Army Unit Resiliency Analysis (AURA) computer simulation model. The AURA outputs are organized into the following three primary sections: Consolidation of Inputs, Intermediate Results, and Final Averaged Results. The format and usage of each AURA output table is described in detail, and an illustrative example is provided for each. The first section, Consolidation of Inputs, provides the analyst with a reference source to verify the initial conditions and parameters being modeled. Section 2, the Intermediate Results, reports the status of the unit and its resources during the course of the mission. The Final Averaged Results Section comprises the third output section and consists of the end-of-encounter results averaged over all replications. Finally, an appendix of error diagnostics is provided to assist the AURA programmer/analyst with error correction and debugging. This section includes suggestions and recommended solution corresponding to each diagnostic warning and error message produced by AURA.

14. SUBJECT TERMS	15. NUMBER OF PAGES
AURA; combat model; unit effectiveness; casualties; chemical; nuclear; conventional : vulnerability	188
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev 2-89)
Prescribed by ANSI Std Z39-18
298-102

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1. INTRODUCTION

The purpose of this report is to describe the output and error diagnostics generated by the Army Unit Resiliency Analysis (AURA) computer simulation model.

It is assumed that the reader is reasonably familiar with the AURA family of methodologies and with the purpose and function of the many options of the AURA model itself. The novice AURA analyst is referred to the AURA Programmer/Analyst Guides (Sheroke 1990a, 1990b) and the AURA Input Manual (Klopcic, Sheroke, and Price 1990) for a comprehensive explanation of the methodologies and capabilities of the AURA model.

The data produced by AURA provides the analyst with the ability to examine, in great detail, the performance capability and status of unit operations over a specified time period including the effectiveness (as well as degradation) of all unit equipment and personnel.

AURA output data is organized in a manner to enable the analyst to examine the scenario modeled ranging from consolidation of inputs to the final (averaged) effectiveness and casualty results. The initial section of an AURA output consists of input consolidation in which the commands, events, assets, and unit deployment are organized into table form to allow the analyst to reference the initial conditions during the trial. The second section of output reports information such as weapon impact points, casualties, nuclear or chemical dosages, and degradation status at specified times during the scenario. The third section of output illustrates the results, summarizing each replication of the AURA encounter. Reported in the third section is unit effectiveness, surviving assets (including degradation due to fatigue or contamination), job status, and mission results. This section consists of the summarized results which have been averaged over all replications. The final unit effectiveness result, AURA's primary fruition, is reported in this section. Finally, the user may optionally request to include a copy of the weapon effects data file used in the study, which will be the last item printed to the AURA output file. Weapon effects data files describe the characteristics inherent to the scenario modeled. The types of weapon effects files are nuclear vulnerability, conventional lethality, and chemical dissemination and are described in Appendix B of Volume 2 (Sheroke et al. 1990a).

The information provided by each output table is generally specific to a particular AURA methodology. For example, when playing a nuclear scenario, the outputs relating to the effects of the nuclear warhead are reported. Typically in an AURA analysis, the analyst must correlate the data from several output tables in order to answer specific questions or further understand the circumstances leading to the final result values. This process, known as cross-referencing, is a common analytical tool employed by the AURA analyst. For example, suppose the unit effectiveness value is shown to degrade from 95% to 60% between the first 2 hours of a chemical scenario. The reason(s) for the degradation can be determined by investigating the data provided by the output tables of the intermediate results section. A possible reason for the unit's degraded capability may be due to the time taken by personnel to realize and react to the detonation of a chemical munition. By varying AURA input parameters, the analyst can model the reaction time which is eminent in such a scenario. In this case, the analyst can reference the Weapon Reliability Table to gain insight into detonation time, range of the weapon effects, and targeting parameters associated with this munition. Another possible cause for unit degradation could be a result of the effects of a chemical attack such as contamination or hindrance due to wearing mission-oriented protective posture (MOPP) gear. The effects of these phenomena will invariably cause a reduction in the unit's effective capability and are described in the Toxic Dose Table and the Degradation by MOPP (and Toxic Kill Criteria [T.K.C.]) Table, respectively. One of the most common factors in limiting the unit's effective capability is the degradation or absence (i.e., casualty) of mission-essential assets. By the usage of user-controlled output commands, AURA will report the role and status of each asset at user-specified reporting times within the scenario. With this information, the analyst can determine which assets or tasks have the greatest impact upon the unit's effective capability to perform its mission.

Finally, the Appendix contains warning and error diagnostics and provides assistance with error correction and debugging. This section includes suggestions and recommended solutions corresponding to each potential warning diagnostic and error message produced by AURA.

2. ORGANIZATION AND CONTROL OF OUTPUT

2.1 General Sequence of Output Tables. Analyses involving the AURA methodology can generate prohibitively large amounts of various kinds of data. It is possible, for example, to print out the impact point of every incoming round. For 100 replications of a study involving a heavy artillery barrage, the impact point output alone could consume upwards of 10,000 pages of computer paper. For this reason, AURA is equipped with output options which allow the user to select the scenario-dependent entities to be printed. For a complete listing and explanation of the output control commands available in AURA, the analyst is referred to the AURA Input Manual (Klopcic, Sheroke, and Price 1990). When no options are invoked, only the default outputs are printed. Default outputs consist of a consolidation of the inputs and a report of the final average results at each reconstitution time. In addition, outputs may contain a number of informative warnings or error messages that alert the analyst to inconsistencies or errors that occur within the input runstream. Familiarity with the organization of the output allows the analyst to locate desired results efficiently and makes for easy comparison between the various tables of an AURA output. The following outline provides the general sequence of the AURA output format.

I. CONSOLIDATION OF INPUTS

- A. Mnemonic Control Cards
- B. Heading
- C. Event Table and Miscellaneous
- D. Weapons
    1. Names, Yields, Delivery Errors
    2. Dispersion Pattern Envelope (TOXIC Rounds)
- E. Assets
    1. Names, Numbers, and Other Accounts
    2. Degradation Information
    3. Reliability and Repair Data
- F. Link Definition Table
- G. Link-Assets Substitutability Matrix
- H. Subchains, Orlinks, Compound Links, and Chains

I. Chain Plots

J. Deployment Table

K. Deployment Plots

II. INTERMEDIATE RESULTS FOR EACH REPLICATION (Optional)

A. Weapon Actual Ground Zero Coordinates

B. Casualties, Contaminations

C. Dosages (Nuclear or Chemical)

D. Repairs Commenced, Ongoing, and Completed

E. Asset Allocation: Commander's Decisions, Available Resources, Weak Link Reports

F. Replication Summaries

III. FINAL RESULTS VS. TIME

A. Unit Effectiveness, Statistics, and Distribution

B. Functional Groups

1. Survivors
2. Dosages
3. Contaminations

C. Link Result Table

D. CHAIN Results

IV. REPEAT OF LETHALITY, VULNERABILITY, AND DISSEMINATION FILES

2.2 Consolidation of Inputs.

2.2.1 Mnemonic Control Cards. An AURA input runstream consists of many sections, each initiated by an AURA command that causes some action to be taken. The commands separate the portions of an input runstream and are referred to as mnemonic control cards. As the input runstream is processed, an output table is printed which lists the mnemonics contained in the runstream. If a syntax error is found in a particular section of the runstream,

an error message or informative warning is included in the output table following the name of the mnemonic being processed. The printing of the mnemonic control cards provides an audit of the input process. That is, if a fatal error is found within the runstream, the user can immediately determine which mnemonic problem occurred. Example 1 illustrates a mnemonic control card listing in which no errors or informative warnings have occurred. Example 2 is an illustration of a mnemonic control card listing with error messages and informative warnings that may occur during pre-processing of input. For a complete discussion of the mnemonics used in AURA, the analyst is referred to the AURA Input Manual (Klopcic, Sheroke, and Price 1990).

2.2.2 Heading, Event Table, and Miscellaneous. Example 3 illustrates the Heading, Event Table, and miscellaneous information which is reported near the beginning of the output. Since an AURA analysis typically consists of a minimum of 100 executions of the code, with each run (also referred to as a trial) being a slight variation from every other run, it is important to clearly identify which inputs are associated with each set of outputs. By accurately identifying each run, confusion and errors which may otherwise occur in the process of analyzing the results can be eliminated. The purpose of this initial section of the input consolidation is to aid the analyst in identifying the unique characteristics of the run through the use of a heading, to summarize the types and sequence of events in tabular format for easy reference, and to further distinguish it by the values assigned to some of the important decision rules used in the optimization process.

In Example 3, the AURA run is identified by the following heading: "152-MM SELF-PROPELLED HOWITZER BATTERY WITH BTRY FDC ONLY." The mnemonic input card HEADING is used to alter the heading on each AURA run and can be used to summarize the important variables of each run. The run is further identified by an ID number, which is simply the date by month/day/calendar year and the time at which the computer run was executed.

The first row of output in the Event Table is a list of initial set of random number seeds. Every AURA run will start with the same set of default random number seeds unless otherwise specified with the mnemonic input card SEEDS. In fact, verifying that the initial random

MNEMONIC CONTROL CARDS
****

1. AGENT
2. DEPLOYMENT
4. DELIVERY ERROR
5. VOLLEY
6. LINKS
7. SUBCHAIN
8. ORLINK
9. COMPOUND LINK
10. CHAIN
11. REPLICATION
12. INTERNAL RECONSTITUTION
13. GO

Example 1. Mnemonic Control Cards 1.

```
MNEMONIC CONTROL CARDS
******************************

  1. DELIVERY
  2. CEP  TLE
  3. CONVENTIONAL
  4. MODE
  5. T.K.C.
  6. MOPP
  7. DEGRADATION
  8. ROUND
  9. VOLLEY
 10. DEPLOYMENT

**WARNING-35 ** COULD NOT FIND ASSET OR LINK NAMED ON SOME DEPLOYMENT CARD(S).  "DUMMY
                LINK(S)" CREATED SEE IDS IN DEPLOYMENT TABLE
 11. DECISION RULES
 12. LINKS

**WARNING-21 ** SOME LINK(S) HAVE NO CORRESPONDINGLY NAMED ASSET(S).  ASSUMING "DUMMY
                (LINKS)" SEE HOME IDS IN LINK DEFINITION TABLE
 13. SUBCHAIN
 14. COMPOUND LINK
 15. CHAIN
 16. INCOMING FIRE DIRECTION
 17. HEADING
 18. REPLICATIONS
 19. INTERNAL RECONSTITUTION TIMES
 20. GO
```

Example 2. Mnemonic Control Cards 2.

AURA RUN
152-MM SELF PROPELLED HOWITZER BATTERY WITH BTRY FDC ONLY
RUN ID # 11/14/90 8:47:20
****

(((RANDOM NUMBER SEEDS AT START = 64310. 58218. 16804 . 93359. 7398.)))

EVENT	TIME	EVENT TYPE	OPERANT CHAINS	WPN NO. / RECUPTIME	NO.RNDS/	DGZ/TLE X	Y	Z	VOLLEY ANGLE	VOLLEY LENGTH
1	0.0	INITIAL	1	INF.						
2	0.0	CONV. LETH	1	1	16	255.00	33.00	0.00	90.00	250.00
3	0.0	CONV. LETH	1	1	16	255.00	98.00	0.00	90.00	250.00
4	5.0	RCNSTITUTE	1	5.00						
5	120.0	RCNSTITUTE	1	120.00						
6	240.0	RCNSTITUTE	1	240.00						
7	360.0	RCNSTITUTE	1	360.00						
8	480.0	RCNSTITUTE	1	480.00						
9	600.0	RCNSTITUTE	1	600.00						
10	725.0	RCNSTITUTE	1	725.00						

MISCELLANEOUS VALUES

NO. OF REPLICATIONS = 100

INTERNAL RECONSTITUTION EVAL. TIMES = 5.0 120.0 240.0 360.0 480.0 600.0 725.0
FRACTIONAL IMPROVEMENT NEEDED TO OVER-RIDE DECISION RULE 0.01
SICKNESS/FATIGUE SUFFICIENT FOR HOME LINK PRE-EMPTION WHEN PERFORMANCE DROPS BELOW 0.75
RELATIVE VALUE IN FINISHING ONGOING NEEDED REPAIR OVER STARTING A NEW NEEDED ONE 2.00
>>>>>>>> INCOMING FIRE DIRECTION (MEASURED CCW FROM THE TARGET X AXIS) IS BETWEEN -90 AND -90 DEGREES <<<<<<<<<
>>>>>>>> DOWN WIND DIRECTION (MEASURED CCW FROM THE TARGET X AXIS) IS BETWEEN 0 AND 0 DEGREES <<<<<<<<<<<<

Example 3. Heading, Event, and Miscellaneous Table.

number of seeds remain constant over a set of runs is an important step in determining the consistency of results for the analysis set.

The next two rows of the table are column headers which identify the information contained in the Event Table. The first column in the Event Table identifies the event number. All events are sequentially numbered in the order in which they are processed. The second column identifies the time at which the event has occurred. In Example 3, event 1 occurs at time 0.0. Units of time are user specified. While not explicitly defined, all units of measure are implied by the input values. Care should be taken to maintain a consistent set of units. The time unit of choice for most AURA analyses is minutes. Column three defines the type of events which have occurred. AURA event types are described in detail in Section 5.b of Volume 1 of the AURA Programmer/Analyst Guide (Sheroke et al. 1990b). As shown in this example, event 1 refers to the initial event for this run. For all AURA runs, the initial event is a reconstitution event occurring at time 0.0 in which AURA initializes all assets to their maximum effectiveness level and primary deployment locations before commencing the run. Events which represent the detonation of a threat weapon are known as lethality events. Lethality event types include TOXIC DISPERSION, CONVENTIONAL, NUCLEAR, and SECONDARY, which identify chemical, conventional, or nuclear weapons attacks, or secondary explosions, respectively. Other AURA event types include the following:

- User-defined internal reconstitution events;
- Change in: delivery errors,
  target location error,
  incoming fire direction,
  wind direction,
  acquisition probability.

The fourth column identifies the chain or mission which is operant at the corresponding time. The use of several chains over different time intervals may be implemented through the use of the mnemonic input CHAINS. Each chain will be identified by a number and ordered in the sequence in which the chain description appears in the input runstream.

The fifth column, which is headed WPN NO./RECUPTIME, will contain either the weapon number or the time for substitution depending upon the type of event identified for the row of information. In Example 3, an infinite (INF) amount of recuperation time has been allowed to pass before the onset of the scenario, which simply means that at the start of the scenario, the unit has been allowed to optimize the use of all assets. This default assumption may be altered through the use of the optional TIME BEFORE ZERO card under the MODE mnemonic. The RECUPTIME (or recuperation time) identifies a time after an event at which the unit commander reconstitutes unit assets by substituting personnel and equipment assets into the most mission-essential tasks in order to maximize unit effectiveness. The values printed for RECUPTIME in this column are the values input under the mnemonic input card INTERNAL RECONSTITUTION TIME. It can also be noted from the data in this column, that only one weapon type was employed in this scenario since all lethality events are associated with weapon No. 1. Weapons are numbered sequentially in the order in which the are read from the runstream. Weapon numbers may be further identified through use of the Weapon Reliability Table, which is shown in the following section.

Column six of the Event Table is delineated by the header NO.RNDS and contains the number of incoming rounds per volley for lethality events. If no rounds are used (i.e., only a volley is specified), this entry will be blank in the table.

The remaining columns of data contain the inputs associated with the particulars of the lethality events which were described in the input runstream via the ROUND or VOLLEY input command. Columns eight and nine identify the aim point, also known as the designated ground zero (DGZ) of the volley. AURA uses the Cartesian coordinate system where the target (military unit) is typically deployed in the x-y plane using meters as the units of measure. Column ten lists the intended height of burst (HOB) which is defined along the z-axis. Column eleven identifies the angle (VOLLEY ANGLE) at which the rounds are dispersed with respect to the range direction (direction of incoming fire), and column twelve reports the distance over which these rounds are spaced. In this example, for the second event (event 2), 16 conventional rounds were fired at the point (255.00, 33.00), and the height of burst was defined to be zero. (Sheroke et al. [1990b] describes the usage of height of burst in modeling chemical, conventional, and nuclear attacks.) These rounds will be evenly dispersed across a distance of 250 m at a 90° angle to the line of fire.

The direction of the line of fire is given under MISCELLANEOUS values as the INCOMING FIRE DIRECTION. As noted in Example 3, the incoming fire direction is measured counterclockwise from the target x-axis. Another miscellaneous value which may be an important factor especially when modeling chemical attacks is the DOWN WIND DIRECTION. The direction of the wind is also measured counterclockwise from the target x-axis. A range of angles is given for both the incoming fire and downwind directions since the capability exists to randomly sample the wind or fire directions over a specified range of angles using the respective mnemonic input cards, INCOMING FIRE DIRECTION and WIND DIRECTION. In this example, these directions were input as constants, both 0°. It is important to note and to ensure the accuracy of the relationships between each of the different coordinate systems used in an AURA run. The line printer plot of the deployment is useful for verification of these coordinate systems, see Sections 2.2.14 and 2.2.15.

Stepping back to the top of the MISCELLANEOUS values, the first value identified is the number of replications of the encounter performed for the particular run. This value should remain constant throughout the production phase of an analysis; however, it is wise to test several values to ensure the stability of casualty and unit effectiveness results. Typically 100 replications is sufficient to ensure good results. AURA encounters which consider a large number of random variables may require as many as 200 replications, which is still not prohibitively large.

The next line of data printed under the MISCELLANEOUS values is the user input values for INTERNAL RECONSTITUTION times. These are the times following each EVENT at which the commander will reorganize and reallocate unit assets in order to maximize unit effectiveness for the mission modeled.

The next three lines of comment under the MISCELLANEOUS values refer to decision rule values. The use of various options under the mnemonic input card DECISION RULES allows for control of certain sets of decision logic employed by the optimization algorithm in choosing assignments into the various unit tasks (LINKS). The first of these decision rule values pertains to the rules governing the substitution of assets into LINKS. In the default case, substitutions are chosen on the basis of versatility. In AURA, the asset's versatility represents how well the asset is cross-trained to perform the tasks within the unit. AURA will initially

attempt to substitute assets based upon their versatility, with the least versatile assets being substituted first. The fractional improvement needed to override this default decision rule is defined by the optional input card PRIORITY. In this example, the fractional improvement in link effectiveness required in order to preempt the default decision rule in favor of substitution on the basis of user-ordered priority is 0.01 (or 1%).

The next line of output provides the value associated with criterion used to replace fatigued or sick personnel. The default value for substitution is set at 0.75. That is, if personnel who are performing the primary duties assigned to them (HOME LINK) become fatigued from lack of rest or sickness due to sublethal dosages of chemical agent or radiation such that their performance drops below 75% of the capability, the commander (the asset allocation algorithm) will search for and replace these assets with other personnel who can substitute into the task at a higher effectiveness value and thereby increase overall unit effectiveness. The default level of degradation required for substitutions to take place may be varied using the option SICKLV under the mnemonic card DECISION RULES.

In Example 3, the relative importance of finishing ongoing repairs is set to 2.0. This means that if an ongoing repair has 0.6 of an item left to fix, the code will calculate the anticipated gain based upon receiving 1.2 (= 2.0 * 0.6) items. The value of this variable is set using the FINISH REPAIR option under the mnemonic input card DECISION RULES. This allows the optimization algorithm to optimize unit performance by selecting for repair the items of equipment which most contribute to the effectiveness of the mission.

2.2.3 Weapon Reliability Table. The Weapon Reliability Table reports a consolidation of the weapon information specified in the input runstream. For each weapon, parameters are defined describing the delivery errors and weapon reliability data. A typical Weapon Reliability Table is illustrated in Example 4.

The first column lists the weapon number. Weapons are numbered with respect to the order in which they appear in the input runstream. The next entry in the table is the weapon type. Weapon type can be conventional, nuclear, chemical, or conventional-chemical and is referenced by the numbers 1, 2, 3, and 4, respectively.

WEAPON RELIABILITY TABLE

....

KEY: TYP = 1 (CONVENTIONAL), TYP = 2 (NUCLEAR), TYP = 3 (CHEMICAL), TYP = 4 (CONV. & CHEM.)

WPN	TYP	YLD (BLST)/ LTHTYP	YLD (RAD)/ MAX EFF. RADIUS	DELIVERY ERRORS RANGE RND TO RND	RANGE VOLLEY	DEFLECTION RND TO RND	DEFLECTION VOLLEY	HOB	RELIABILITY RND	RELIABILITY VOL	NAMES
1	1	1	71.	(41.00 ,	83.00)	(9.00 ,	52.00)	0.0	1.00	1.00	CON1, CONVENTIONAL

(DELIVERY ERROR .GT. 0. MEANS NORMALLY DISTRIBUTED. .LT. 0. MEANS UNIFORMLY DISTRIBUTED.)

+++

+ INITIAL TLE = (85.00, 85.00) DISTR. = NORMAL INITIAL ACQUISITION PROB. = 1.00 +

+++

Example 4. Weapon Reliability Table.

The next column of the Weapon Reliability Table reports either the nuclear blast yield (YLD [BLST]) or lethal type (LTHTYP) for conventional and chemical runs. When playing a nuclear scenario, the yield (blast) refers to the size of the nuclear weapon. For example, if a 5-kt bomb is specified in the input runstream, then 5.00 KT would appear in this column. When the scenario being modeled is chemical or conventional, the lethal type for the weapon deployed will be listed in this column. Possible lethal types for chemical include G, V, and H for nonpersistent, persistent, and blistering agents, respectively. For a conventional weapon, the lethal type will always be represented by a "1."

The fourth column contains either the nuclear radiation yield (YLD [RAD]) or the maximum effective radius for conventional and chemical runs. The radiation yield will be the same as the blast yield unless a second yield is specified in the YIELD section of the input runstream. The second yield is optional and allows the user to model enhanced radiation effects. When this option is used, the value specified in the inputs will appear in this column of the table. For further information on the YIELD command, the user is referred to Volume 1 of the AURA Programmer/Analyst Guide and the AURA Input Manual (Sheroke et al. 1990b; Klopcic, Sheroke, and Price 1990). For conventional and chemical scenarios, column four contains the maximum effective radius for the given weapon. The maximum effective radius is simply the radius from the actual ground zero in which the weapon effects occur. In other words, no weapon effects are taken into consideration beyond this radius.

The next portion of the Weapon Reliability Table contains the delivery errors defined for each weapon. Delivery error values greater than zero indicate that the error is sampled from a normal distribution while values less than zero indicate that the error is sampled from a uniform distribution. A message stating this relationship is included following the tabulated weapon information. Round-to-round and volley refer to the error in round and volley delivery, respectively. Round-to-round and volley errors are given for both the range and deflection. Range refers to the distance between the gun and the target, whereas deflection refers to the number of meters to the right or left of the aim point with respect to the firing direction. When sampling from a normal distribution, the values given in the table are standard deviations from the designated ground zero in both range and deflection for the round and volley. When sampling from a uniform distribution, these values relate to the maximum distance from the aim point, in range and deflection, that the round may fall. For more detail on delivery errors,

the user is referred to the DELIVERY ERROR sections of Volume 1 and the AURA Programmer/Analyst Guide and the AURA Input Manual (Sheroke et al. 1990b; Klopcic, Sheroke, and Price 1990).

The next entry in the table is the height of burst (HOB), which is simply the "z" coordinate or the distance above the ground at which the weapon detonates. Following the HOB is the round and volley reliability data for each weapon. The default value for both the round and volley is 1.00, which means that each round and volley has a probability of detonation of 100%. This value will always appear in the table unless otherwise specified in the input runstream. The last column of the table reports the names for the weapon listed. This column contains the primary name, followed by any alternative or secondary names defined for each weapon.

Finally, under the tabulated data described above, is a line of additional information concerning the weapon(s) deployed. The first item reported is the initial target location error (TLE). TLE values are standard deviations that represent the distance from the aim point within which the target is expected to lie approximately one-third of the time. Similar to the delivery error is the relation between the sign of the values given for the TLE and the distribution that is modeled (i.e., values greater than zero indicate sampling from a normal distribution, while values less than zero indicate sampling from a uniform distribution). The type of distribution that is being used is listed following the information for the TLE. For a complete discussion of target location errors, the user is referred to Volume 1 of the AURA Programmer/Analyst Guide (Sheroke et al. 1990b). Next, the initial acquisition probability is given. This value indicates the probability of acquiring the target. When no data is given for this input, the AURA code assumes a value of 1.00 or 100% probability of target acquisition.

2.2.4 Toxic Dissemination Summary. Example 5, the Toxic Dissemination Summary Table, details the characteristics inherent to the employment of chemical weapons such as the following: contamination times, agent type, dissemination pattern, and levels of concentration. The values reported in the summary are calculated by the Non-Uniform Simple Surface Evaporation (NUSSE) model, which is the chemical dissemination and transport methodology used by AURA. Developed by the U.S. Army Chemical Research, Development, and

```
TOXIC DISSEMINATION SUMMARY
***********************************


 1 BOMB          CONTAMINATION (>   1.00)       TIMES    (MIN/MAX)  =        0.21     90.00   PRSTIM = 100.33
                                                DWNWND   (MIN/MAX)  =       70.00   1000.00
                                                CRSWND   (MIN/MAX)  =      -90.00     90.00


                 DOSAGE: VAPOR/PERCUTANEOUS    TIMES :       0.25        1.00     7.50     8.33       16700.00

                      VAPOR (>1.34E+02)         DWNWN    (MIN/MAX)  =      120.07    577.18
                                                CRSWND   (MIN/MAX)  =      -22.98     22.98
                      VAPOR (>1.34E+01)         DWNWND   (MIN/MAX)  =       89.59   1209.37
                                                CRSWND   (MIN/MAX)  =      -69.68     69.68
                      PERC.   (>4.69 +03)       DWNWND   (MIN/MAX)  =      -88.07    231.45
                                                CRSWND   (MIN/MAX)  =      -13.40     13.40
                      PERC.   (>4.69E+02)       DWNWD    (MIN/MAX)  =       63.25    499.24
                                                CRSWND   (MIN/MAX)  =      -30.93     30.93

   MAXIUM CONCENTRATION: 3.27E+01 AT  (DOWNWIND/CROSSWIND)  240.00   0.00 AT TIME   0.80

   NOTE: TIME TAKEN FOR CLOUD TO DRIFT PAST UNIT IS: 10.38

   ***** DOSAGES CONVERTED TO IV BEFORE FINAL REPORT *****
           EXPONENTS (INHAL., PERC.) =   0.7000  0.4800
```

Example 5. Toxic Dissemination Summary Table.

Engineering Command (CRDEC), the methodology encompassing NUSSE and its applicability within AURA is detailed in Sheroke (1990b). It should be noted that NUSSE Output is prepared for input to AURA by the preprocessor, PRETOX (Hindman 1990). The complete listing of information provided by PRETOX may be appended to the AURA standard output file by use of the LETHALITY output option.

The Toxic Dissemination Summary Table is of primary use as a reference source when modeling chemical environments. The following information provides the analyst with the necessary knowledge to best utilize and understand the information provided by the Toxic Dissemination Summary.

The first section of the table reports the minimum contamination level and corresponding dissemination pattern to be considered for the modeling scenario. The contamination value is input into NUSSE as the minimum deposition level of the chemical agent. The contamination value is specified in milligrams per square meter (mg/m^2). The corresponding chemical cloud pattern characteristics are also reported in this section and include the cloud arrival and evaporation times, the cloud pattern dimensions (in terms of downwind and crosswind coordinates), and the persistence time (PRSTIM) of the chemical pattern. In Example 5, the minimum deposition level considered is 1.0 mg/m^2, the arrival time is 0.21 min, and the evaporation time is 90.0 min. The length of the cloud pattern is described by the coordinates given in the downwind direction. In this example, the length of the pattern is from 70 m to 1,000 m on the modeling grid. Likewise, the width of the pattern is described in terms of the crosswind coordinates. The width of this pattern in this example ranges from -90 m to 90 m. The last datum provided in this section describes the persistence time (PRSTIM) of the chemical cloud. Defined in terms of minutes, the persistence time reflects the total amount of time (evaporation time plus additional time required for the cloud to 'drift' away) the chemical will remain in effect during which the contamination level exceeds the minimum contamination considered.

The next section of the Toxic Dissemination Summary Table briefly describes the chemical dosage to be considered for the modeling scenario. The chemical dosage section first reports the times of interest or sampling times (in minutes) to be considered for the scenario. The remainder of this section describes the dosage characteristics of the chemical agent(s)

employed. For each type of hazard (vapor or percutaneous), the information reported is the minimum dosage level and the length/width of the cloud pattern. Also reported for each chemical hazard are the concentration level and pattern coordinates. These values are normalized with respect to the minimum level of contamination considered by AURA. In Example 5, the information describes a vapor hazard which will be evaluated to a minimum dosage level of at least (134.0 mg-min.)/(m^3). The length of the cloud pattern associated with this vapor agent ranges from 120.07 m to 577.18 m. The width of this agent's cloud pattern ranges from -22.98 m to 22.98 m. Similar information is reported for the maximum dosage level of the vapor agent and both the minimum and maximum dosage levels of the percutaneous agent. The analyst is reminded that this table is a brief description of the chemical cloud pattern. A complete description may be obtained through use of the output option, LETHAL. (See Input Manual.)

The next section reported in the Toxic Dissemination Summary Table describes the value, location, and time of the peak concentration level realized during the given scenario. In this example, the peak concentration level attained in the pattern was 32.7 mg/m^3 at pattern coordinate (240., 0.) at .80 min after munition detonation.

Finally, the time required for the cloud to drift past the unit is reported. Based on unit size and wind speed, this time is simply the difference between the persistence time and evaporation time of the chemical cloud.

2.2.5 Asset Table. The Asset Table reports the status of all assets deployed in the unit. The table is separated into two parts with the first containing a list of personnel and the second containing a list of equipment. The personnel assets section can be output in two fashions. When playing sleep deprivation (using the FATIGUE mnemonic), AURA reports each asset's sleep deprivation status in conjunction with the information provided in the asset status table. If sleep deprivation is not being played, the Asset Status Table reports the names and associated data for all assets listed in the input runstream. Example 6 illustrates a typical Asset Table. Example 7 illustrates the personnel section of an Asset Table where sleep deprivation was modeled. Each format of the Asset Status Table is described in the following paragraphs.

PERSONNEL

ID	VRS	NO. DPLOYD	NAMES
1	2	1.0	FIREMEN, PERSONNEL
2	2	20.0	FIRETEAM, PERSONNEL
16	3	2.0	USERS A, PERSONNEL, USER
17	3	2.0	USERS B, PERSONNEL, USER
18	3	2.0	USERS C, PERSONNEL, USER
19	3	2.0	USERS D, PERSONNEL, USER
20	3	2.0	USERS E, PERSONNEL, USER

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EQUIPMENT

ID	VRS	IVL	CNTBU	PRSFC-MX/MN	SPECIAL FACET	ASSOC VALUE	NO.	NAMES
3	1	-1	1	1.00/1.00			4.00	RECORDS
4	1	-1		1.00/1.00			6.00	CRANES
5	2	-1		1.00/1.00			1.00	FRKLFT6A, FORKLIFT6, FORKLIFT
6	2	-1		1.00/1.00			1.00	FRKLFT6B, FORKLIFT6, FORKLIFT

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WHERE:

ID	internally assigned asset number
VRS	versatility, jobs this asset can do
IVL	= 0 -- Personnel < 1 -- No data specified > 1 -- Nuc Vuln Code #
CNTBU	chains in which this item can be used in a contaminated state
PRSFC	maximum and minimum persistence factors (pertain to chemical contamination
SPECIAL FACET	indicates special characteristic of asset. possible entries are: "XPND BY RPR" and "2NDRY EXPL"
ASSOC VALUE	value associated with special facet characteristic - ie. expenditure rate for XPD BY RPR special facet.
NO. DPLOYD	number of items deployed

Example 6. Assets Table - Basic.

ASSETS
****

PERSONNEL

ID	VRS	NO REST	MUST REST	REST DURATN	STRTNG SLUNITS	FAT MULT	THRESH MULT	MAX UPTIME	NO. DPLOYD	NAMES
1	2	1520.0	0.0	240.0	1520.0	1.0	1.0	1.0	-1.0	FIREMEN, PERSONNEL
2	2	1520.0	0.0	240.0	1520.0	1.0	1.0	1.0	-20.0	FIRETEAM, PERSONNEL
16	3	1520.0	0.0	240.0	1520.0	1.0	1.0	1.0	2.0	USERS A, PERSONNEL, USER
17	3	1520.0	0.0	240.0	1520.0	1.0	1.0	1.0	2.0	USERS B, PERSONNEL, USER
18	3	1520.0	0.0	240.0	1520.0	1.0	1.0	1.0	2.0	USERS C, PERSONNEL, USER

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Example 7. Assets Table - With Fatigue Data.

The asset identification number (ID), versatility (VRS), number of assets deployed (NO. DPLOYD), and NAMES are entries common to both the personnel and equipment portions of the Asset Table. The first column lists the identification number of each asset. This number is internally assigned by the AURA code and is unique to each asset. The next column contains the asset's versatility value. Versatility refers to the total number of jobs that an asset can perform within the mission modeled. For example, a record clerk may have a versatility number of three. This means that the record clerk is able to perform the job of a record clerk and has the ability to substitute into two other jobs if necessary. Versatility may be viewed as the depth of cross-training an asset possesses. The next to the last entry in each section of the Asset Table is the number of assets deployed. The number deployed is the total number of assets comprising that particular asset group. The right-most column of the Asset Table contains the unique asset name followed by any alternate names specified for that asset in the input runstream. Alternate names are used to associate common parameters to groups of assets. The user is referred to the AURA input manual for more information on the NAMES mnemonic (Klopcic, Sheroke, and Price 1990).

Entries contained solely in the equipment portion of the asset table include the nuclear vulnerability code (IVLARY or IVL), the contaminated but usable assets, maximum and minimum chemical agent persistence factors, special facet, and associated value. IVL is a multi-purpose variable that enables AURA to both distinguish whether an asset is personnel or equipment or when modeling a nuclear scenario, report the nuclear vulnerability code for equipment assets. An IVL value of "0" indicates a personnel asset, and a nonzero IVL value indicates equipment. Since AURA separates personnel and equipment prior to reporting this table, the IVL value is not reported in the personnel section. For equipment assets, an IVL value of "-1" indicates that there is no nuclear vulnerability data entered for the equipment, whereas an IVL value greater than zero corresponds to the nuclear vulnerability code assigned to the equipment which AURA uses to translate how to model the nuclear effects on that equipment asset.

The next entry under the equipment section of the Asset Table is the contaminated but usable assets. This entry lists the number of the chain in which this item can be used if contaminated. In a chemical scenario, the minimum and maximum persistence factors for the chemical agent are reported.

The next entries are the special facet and associated value. Special facet refers to some characteristic of the listed asset that is not common to every asset. For example, a special facet may be "expendable by repair" or "secondary explosive source." Some special facets have an associated value which further describe the special facet. If "expendable by repair" is listed as a special facet, then an expenditure rate for that asset will be reported under the associated value. An example of a special facet with no associated value would be a "secondary explosive source" in which the associated value entry would typically remain blank.

When modeling FATIGUE, the personnel portion of the Asset Table includes seven additional data values relating to the fatigue/sleep deprivation status of each asset. These values are output between the "VRS" column and the "NO. DEPLOYD" column headers of the standard Asset Table. The first of these columns, "NO. REST," contains the maximum amount of SLUNITs allowable for each asset. Recall, a SLUNIT (SLeep UNIT) is a unit of measure used to represent the amount of rest associated with a personnel asset (1 SLUNIT = 1 min of fully efficient rest). In other words, once an asset accumulates a particular amount of SLUNITs, the asset will not be allowed to rest until some SLUNITs are used (SLUNITS are expended by working). The second column, headed by "MUST REST," reports the minimum amount of SLUNITs allowable for each asset. In other words, once an asset falls below this level of stored SLUNITs, the asset will be forced to rest. The third column is headed by "REST DURATION" and contains the value of duration of rest for each asset. The rest duration value is the amount of time that an asset must be allowed to rest once assigned to sleeping quarters. The fourth column reports the amounts of SLUNITS that each asset possesses at the start of each replication. The fifth column reports the fatigue rate multiplier (FAT MULT) assigned to each asset. The fatigue rate multiplier is an optional user-defined parameter which allows the user to give a distribution of fatigue rates for all assets in a job. This allows the modeling of the variances in fatigue rates for each person within the link or job. The threshold multiplier reported in the next column enables the assignment of threshold values for the upper and lower limits of asset fatigue rates. The threshold values can be used in conjunction with the fatigue rate multiplier to describe an asset's resiliency toward fatigue/sleep deprivation. For example, a weak asset would have both a high fatigue rate multiplier and high threshold multiplier values, while a strong asset would have low fatigue rate and threshold multiplier values. The final data value reported when playing fatigue is the

maximum uptime (MAX UPTIME) parameter. This value, like the fatigue multipliers, is an optionally assigned parameter. The maximum uptime parameter refers to the maximum amount of time (in minutes) an asset is permitted to function without sleep. The maximum uptime parameter allows the user to define the maximum amount of time that an asset is capable of working without sleep.

2.2.6 Nuclear Posture and Shielding Table. The Nuclear Posture and Shielding Table, shown in Example 8, reports the nuclear neutron-to-gamma dosage ratios associated with each nuclear posture as declared via the SHIELDING command. The first column of the Nuclear Posture and Shielding Table simply reports the nuclear posture as defined by the SHIELDING command. Columns 2–5 represent the nuclear shielding factors, defined as neutron-to-gamma ratios for each nuclear posture. The nuclear shielding factors are defined as the ratio of nuclear neutron dosages with respect to the fraction of the incidental gamma dosage. In AURA, the nuclear shielding factors are described by each of the following ratios:

(N, N) - Neutron-to-neutron;
(N, G) - Neutron-to-gamma;
(G, N) - Gamma-to-neutron;
(G, G) - Gamma-to-gamma;

The ratio (A, B) reported is the fraction of dosage of Type B due to an incident dosage of Type A. For example, in the second ratio described above, the resultant ratio would be the fraction of gamma dosage (G) due to the incident neutron dosage (N). This is expressed as (N, G) and represents the neutron-to-gamma ratio for the posture. Associated with each posture is a full matrix of shielding factors—namely, (N, N), (N, G), (G, N), and (G, G). Column six of the Nuclear Posture and Shielding Table contains the description of the associated nuclear posture number. In AURA, the nuclear postures are defined as follows:

NUCLEAR POSTURE AND SHIELDING
****

NUCV	(N ,N)	(G, N)	(N, G)	(G, G)	DESCRIPTION	BLAST ASSOC. ID
1	1.00	0.00	0.00	1.00	OPEN	
2	1.00	0.00	0.00	1.00	OPEN-NO THRM	
3	0.30	0.00	0.00	0.30	FOXHOLE	
4	0.90	0.00	0.00	0.90	APC	
5	0.50	0.00	0.00	0.50	TANK	

AVERAGE ATMOSPHERE FOR THERMAL TRANSMISSION

PERSONNEL NOT IN MOPP GEAR ARE IN SUMMER UNIFORM

Example 8. Nuclear Posture and Transmission Table.

Nuclear posture number	Description of battlefield posture
1	In the open
2	In the open but thermally shielded
3	In a foxhole
4	In an armored personnel carrier
5	In a tank

The Nuclear Posture and Shielding Table next reports the two meteorological conditions which AURA considers in the nuclear environment: atmospheric quality and MOPP uniform type. The atmospheric quality is specified in general terminology and may be defined in the THERMAL input command as GOOD, AVERAGE, or POOR. The default atmospheric quality in AURA is AVERAGE. The uniform type is also described in the THERMAL command and is defined as SUMMER or WINTER. The default uniform type is SUMMER. AURA's nuclear vulnerability methodology (described in Volume 1) details the impact of these meteorological conditions to unit personnel.

Finally, if the associated asset name option is specified within the SHIELDING command, the Nuclear Posture and Shielding Table prints the name of the associated asset in the last column. To explain further, usage of the associated asset name option affords the personnel assets in a vehicle the same nuclear blast criterion as the associated vehicle. Therefore, the personnel assets in a vehicle will be considered casualties when the vehicle becomes a casualty.

2.2.7 Toxic Penetration Factors Table. The Toxic Penetration Factors Table reports the degradation inherent to personnel in a chemical environment. The two items reported in this table are the degradation resulting from wearing mission-oriented protection posture (MOPP) gear and the dosage multiplier, which is input under the Toxic Kill Criteria (T.K.C.) card and defined for each asset group. Example 9 illustrates the Toxic Penetration Factors Table. The toxic penetration factors table is a default output produced by AURA. That is, the table will be printed regardless of scenario modeled. If a chemical scenario is not modeled, the toxic Penetration Factors Table will contain the default values assigned for MOPP and T.K.C. and will have no impact on the nonchemical scenario. The MOPP values reported in the

DEGRADATION BY MOPP AND TOXIC KILL CRITERIA
TOXIC PENETRATION FACTORS
****

MOPP V and higher only appear when explicitly modeled.

TOXIC K.C. CODE		DOSAGE MULT	MOPP 0	MOPP 1	MOPP 2	MOPP 3	MOPP 4	MOPP 5
FIRE CONTROL	1	1.0	1.00	0.90	0.47	0.80	0.25	1.00
LIGHT PHYSICAL	2	1.0	1.00	—	0.81	—	0.37	1.00
SUPERVISOR	3	1.0	1.00	—	0.78	—	0.44	1.00
MAINTENANCE	4	1.0	1.00	—	0.72	—	0.16	1.00
CLERICAL	5	1.0	1.00	—	0.94	—	0.94	1.00
PENETRATION FACTORS, VAPOR			1.00	1.00	1.00	0.00	0.00	0.00
PENETRATION FACTORS, PERC.			1.00	0.20	1.00	0.03	0.00	0.00

Example 9. Toxic Penetration Factors Table.

nonchemical scenario may be useful to present the case when personnel are required to don MOPP gear upon the arrival of every incoming round until an all clear (i.e., false alarm signal) has been given.

The first column, the T.K.C. Code, lists the toxic kill criteria code numbers and descriptions that have been defined in the input runstream under the mnemonic T.K.C. The next column lists the dosage multiplier (also defined under the mnemonic T.K.C.). The dosage multiplier is used to simulate higher/lower than normal dosage ratios, as would be acquired by a person whose task required a higher/lower than normal breathing rate. The subsequent five columns, headed by MOPP0, MOPP1, . . . , MOPP4, report the effective fractional capability of an asset to perform its assigned task while in MOPP. For example, in the column headed by MOPP0, which means no MOPP gear is worn, the personnel in all categories can operate at 100%. The degradation due to MOPP is in direct proportion to the level of MOPP gear being worn. The degradation values for the various MOPP postures may be defined under the DEGRADATION mnemonic. If the MOPP values are not defined in the input runstream, the MOPP table reports the AURA defaults for MOPP for the first asset listed in the table. While all values are printed in the table, AURA has the capability to model only two postures, the original posture and the alternate posture, as specified in the input runstream. In Example 9, the original and alternate postures are MOPP2 and MOPP4, respectively. The printing of default values under MOPP0, MOPP1, and MOPP4 does not affect results. In Example 9, entries under MOPP2 and MOPP4 are user-specified inputs. Values listed under MOPP0, MOPP1, and MOPP4 are defaults. The dashes listed under MOPP1 and MOPP3 indicate that there are no data for these entries. Generally, only four levels of MOPP are modeled under the current doctrine; however, AURA provides the capability to define alternative MOPPs if necessary. MOPP5 and above may be defined as needed to model special postures which may be required within the infinite spectrum of modeling possibilities. It should be noted that although the term MOPP is used, this terminology also applies to the modeling of chemical protective postures of red units. For these special postures, the user must define the values for the various T.K.C. codes as well as the MOPP degradation values. For more information on T.K.C. and MOPP degradation values, the user is referred to the AURA Input Manual (Klopcic, Sheroke, and Price 1990).

Following the T.K.C. and MOPP degradation information are the toxic penetration factors for vapor (agents that affect personnel through inhalation) and percutaneous (agents that are absorbed through the skin) hazards. Vapor and percutaneous dosages are reported in Example 9 as a fraction of the total possible dose that can be received for each of the various MOPP levels. As the MOPP posture increases, or more protective clothing is donned, the fraction received by inhalation or absorption decreases. For instance, in Example 9, under MOPP0 (no protective clothing worn), the percentage of the total dose received is 1.00 or 100%. Under MOPP1 (overgarment only), the value for vapor hazard remains at 100% while the value for percutaneous hazard has dropped to 0.20 (or 20%). The values for the penetration factors may be specified under the mnemonic MOPP. When no specifications are given, the default values are reported for the various MOPP postures. As in the case of the degradation by MOPP, values for the penetration factors may be specified for MOPP postures of five and above when deemed necessary. Further information on penetration factors may be found in the AURA Input Manual (Klopcic, Sheroke, and Price 1990).

2.2.8 Repairable Item Data Table. The Repairable Item Data Table prints the input data related to the repair of damaged or failed equipment. Repairs can be specified at three levels: 0 = decontamination needed (chemical only), 1 = light repair needed, and 2 = medium repair needed. For each repairable asset group, the Repairable Item Data Table contains a line of data for each type of repair that has been specified. For example, if light and medium repairs have been specified for an asset group, then a line of data for light and a line of data for medium repair will be printed in the table. If decontamination is needed in addition to light and medium repair, then a third line pertaining to decontamination will be printed for that asset group. In Example 10, both light and medium repairs have been specified for all repairable assets; therefore, two lines of data are included in the table for each asset.

The first column of the Repairable Item Data table lists the identification number and name for each repairable asset group. The next column reports the damage levels (or repair levels) that have been specified for each asset. Light damage may be thought of as any damage that will take one hour or less to repair and medium damage as damage that will take from 1 to 8 hr to repair. Alternately, light damage may be thought of as damage repairable by the crew and medium damage as damage repairable by organizational level assets. Heavy damage is considered to be unrepairable and is not reported. Combat damage is the third

REPAIRABLE ITEM DATA
****

NOTE : DAMAGE LEVEL = LIGHT (1 HR. OR LESS TO REPAIR), = MEDIUM (1 - 8 HOURS TO REPAIR)

ID	DAMAGE LEVEL	COMBAT DAMAGE	PENALTY	MEAN TIME	STD. DEV.	REPAIR LOCATION		REPAIR CONSTRUCT
80 FORK B	LIGHT	NO	1.0	60.0	30.0	1112.0	1225.0	125
80 FORK B	MEDIUM	NO	1.0	180.0	90.0	1112.0	1225.0	125
81 FORK CI	LIGHT	NO	1.0	60.0	30.0	1112.0	1225.0	125
81 FORK CI	MEDIUM	NO	1.0	180.0	90.0	1112.0	1225.0	125
82 FORK 247	LIGHT	NO	1.0	60.0	30.0	1112.0	1225.0	125
82 FORK 247	MEDIUM	NO	1.0	180.0	90.0	1112.0	1225.0	125
92 CRANE B	LIGHT	NO	1.0	60.0	30.0	1120.0	1263.0	125
92 CRANE B	MEDIUM	NO	1.0	130.0	90.0	1120.0	1263.0	125
93 CRANE CI	LIGHT	NO	1.0	60.0	30.0	1120.0	1263.0	125
93 CRANE CI	MEDIUM	NO	1.0	180.0	90.0	1120.0	1263.0	125
94 CRANE 247	LIGHT	NO	1.0	60.0	30.0	1120.0	1263.0	125
94 CRANE 247	MEDIUM	NO	1.0	180.0	90.0	1120.0	1263.0	125
119 OVENS	LIGHT	NO	1.0	60.0	30.0	1109.0	1228.0	125
119 OVENS	MEDIUM	NO	1.0	180.0	90.0	1109.0	1228.0	125
120 PUMP100	LIGHT	NO	1.0	60.0	30.0	1112.0	1265.0	125
120 PUMP100	MEDIUM	NO	1.0	180.0	90.0	1112.0	1265.0	125
122 WATER TRLR	LIGHT	NO	1.0	60.0	30.0	1109.0	1228.0	125
122 WATER TRLR	MEDIUM	NO	1.0	180.0	90.0	1109.0	1228.0	125

GENERAL REPAIR LINK / SUBCHAIN (REQUIRED FOR ANY REPAIR AT LEVEL 1) *12

GENERAL REPAIR LINK / SUBCHAIN (REQUIRED FOR ANY REPAIR AT LEVEL 2) *12

Example 10. Repairable Item Data Table.

entry in the table. If combat damage repair has been specified for this asset, then "YES" will be printed in this column, otherwise "NO" combat damage repair will be performed. Next, the penalty for repair is reported. Penalty is the loss in unit effectiveness that will be accepted in order to repair the damaged asset. The mean time for repair is the next datum reported in the table. Following the mean time entry is the standard deviation (STD. DEV.) of the mean time for repair. In Example 10, the mean time of repair for asset number 80 (FORKLIFT B) is reported as 60.0 min. The standard deviation of the mean time of repair for the forklift asset is reported as 30.0 min.

The final two entries reported in the Repairable Item Data Table are the repair location and repair construct for the asset group. The repair location is simply the coordinates of the location at which repair of the item at the reported level would take place. The repair construct refers to the number of the construct being used to complete the repair.

General repair is an option used to specify that, in order to perform the repair, a special link is needed. This link may not necessarily be the actual repair link but is required in addition to the standard repair assets. When the general repair option is used, an informative message stating the general repair link that is needed to perform the specified levels of repair is printed following the tabulated information described above. In Example 10, general repair messages have been printed for level 1 and level 2 repairs. The link needed for both levels of repair is "*12." The asterisk preceding the number indicates that the construct represents a subchain.

2.2.9 Parameters for Calculating Heat Stress Table. The Parameters for Calculating Heat Stress Table, illustrated in Example 11, is printed only when modeling heat stress. The table is divided into the following three sections: parameters relating to personnel, clothing parameters, and meteorological condition parameters. These parameters are user-specified under the HEAT STRESS command (Klopcic, Sheroke, and Price 1990). AURA uses these parameters in conjunction with the Goldman-Givoni heat stress methodology to calculate the effects of heat stress on unit personnel (McNally, Stark, and Ellzy 1990).

The first section of the Parameters for Calculating Heat Stress Table reports the parameters relating to personnel (that is, skin temperature (°C), percent dehydration, increase

PARAMETERS FOR CALCULATING HEAT STRESS
****

PERSONNEL PARAMETERS

SKIN TEMPERATURE	= 36.50
PERCENT DEHYDRATION	= 3.00
INCREASE IN DEHY/DA	= 0.00
DAYS OF ACCLIMATION	= 12.00

CLOTHING PARAMETERS

MOPP	CLO	IM/CLO	GAMMAC	GAMMAI
1	1.13	0.43	0.26	0.38
2	2.11	0.23	0.26	0.38
3	1.13	0.43	0.26	0.38
4	1.89	0.16	0.26	0.38
5	1.13	0.43	0.26	0.38
6	1.13	0.43	0.26	0.38
7	1.13	0.43	0.26	0.38
8	1.13	0.43	0.26	0.38

METEOROLOGY VS. TIME

START	STOP	TEMP	HUMID	WIND	MMI	MMA
0.0	127500.0	36.67	20.00	3.00	9 999.99	9999.99

Example 11. Parameters for Calculating Heat Stress Table.

in dehydration per day, and days of acclimatization). The AURA defaults for skin temperature, percent dehydration, and days of acclimation are 36.0, 0.0, and 12.0, respectively. The user is referred to the previous reference for a comprehensive explanation of AURA's heat stress methodology (McNally, Stark, and Ellzy 1990).

The next section of the table reports the clothing parameters for each MOPP level defined in the scenario being modeled. Clothing parameters include the MOPP level, clothing - insulative properties (CLO), clothing - evaporation properties (IM/CLO), wind correction factor for insulative properties (GAMMAC), and wind correction factor for evaporative properties (GAMMAI).

Parameters relating to the meteorological conditions over time are printed in the third section of the table. The items reported are the start and stop times for the meteorological time period, the ambient temperature (TEMP) (°C), the relative humidity (HUMID) (0–100%), the wind speed (WIND) (m/s), maximum allowable metabolic rate for initial MOPP (MMI) (watts), and the maximum-allowable metabolic rate for alternate MOPP (MMA) (watts). The default values for these parameters are as follows:

Meteorological time period = 20.0 min
Ambient temperature = 20.0° C
Relative humidity = 3.0%
Maximum metabolic rate (initial MOPP) = 1.E35 W
Maximum metabolic rate (alternate MOPP) = 1.E35 W

2.2.10 Link Definition Table. The Link Definition Table, illustrated in Example 12, contains the parameters used to model the subtasks which can be performed by elements of the unit specified in the input runstream. This information can be used by the analyst to reference the initial status and structure of each link. In the following paragraphs, this table's contents are defined and described. The first column of this table contains the link numbers which are assigned to each link by AURA according to the order that the links are input. The link names are listed in column two. Links preceded by an asterisk denote a personnel asset. In the bottom row of the Link Definition Table, under NAME, is the NOT IN LINK category. This category represents assets which are available to the unit, but have not been designated as primary assets in a HOMELINK.

LINKS
****

LNK	NAME	HOME ID	NUMBER IN LINK	MAX IN	MAX EFF	MIN IN	MIN EFF	MAX IN LINK	ASSOC LINK	LNK GRN	DGR SET	FATIG RATE	SLEEP DEMND	QUIT EFF	METAB RATE
1	*FIREMEN	1	-1.00	0.50	100	0.00	0	UNLMTD	NONE	0.50	0			0.100	250.0
2	*FIRETEAM	2	-20.00	20.00	100	0.00	0	UNLMTD	NONE	0.50	0			0.100	250.0
3	*CH AMMO INSP	54	3.00	2.00	100	0.00	90	4.00	NONE	0.50	0			0.100	250.0
4	*AMMO CLERK	44	2.00	2.00	100	0.00	80	2.00	NONE	0.50	0			0.100	250.0
5	*RECORD CLERK	45	8.00	8.00	100	2.00	25	2.00	NONE	0.50	0			0.100	250.0
.	.	.	.	.	.	.	.	.	.	.	.			.	.
.	.	.	.	.	.	.	.	.	.	.	.			.	.
.	.	.	.	.	.	.	.	.	.	.	.			.	.
53	TRAILER25	39	1.00	1.00	100	0.00	90	UNLMTD	NONE	0.50				0.100	250.0
54	NOT IN LINK		165.00												

HOME ID	- The internal number of the asset for which the link was named
NUMBER IN LNK	- A cross reference of how many items were deployed to serve in each link (Note: the dummy links are designated as occupied by a negative number of items)
MAX IN	- The number of effective assets required for maximum task effectiveness
MAX EFF	- The maximum effectiveness attainable for task
MIN IN	- The number of effective assets required for minimum task effectiveness
MIN EFF	- The minimum effectiveness attainable for task
MAX IN LNK	- The maximum number of assets (regardless of individual effectiveness) which can be assigned to a task
ASSOC LINK	- Another task whose potential fulfillment controls the entities assignable to the current task
LNK GRN	- Allows user to allocate links to multiple jobs (Default: 0.50)
DGR SET	- Initial MOPP degradation value
FATIG RATE	- Fatigue rate assigned to link and only printed when modeling sleep deprivation
SLEEP DEMND	- Optimal number of SLUNITs required
QUIT EFF	- Effectiveness level of link below which a substitution will not be made (Default: 0.100)
METAB RATE	- Metabolic rate as defined in input runstream (Default: 250.0)
NOT IN LINK	- The number of items deployed which have no primary job

Example 12. Link Definition Table.

In the third column, the HOME ID number of the link is shown. This number is the internal number of the assets for which the link was named. The HOME ID number is assigned by AURA according to the sequence that the item was input under the ASSET section of the input runstream. Column four contains a listing of the number of items deployed and available to serve each link. Note that the DUMMYLINKs are designated as being occupied by a negative number of items. The number of substitutes needed to reach maximum effectiveness is the number following the negative sign. For example, for FIRETEAM, the value -20 means that it is a dummy link and it needs 20 substitutes to reach maximum effectiveness.

In the fifth column, the number of effective assets required for maximum task effectiveness (MAX IN) is described. The "MAX EFF," which is the maximum effectiveness attainable by the task, appears in column six; and column seven represents the number of effective assets required for minimum task effectiveness (MIN IN). Column eight reports the minimum effectiveness attainable for each link (MIN EFF). Column nine contains MAX IN LINK, which represents the maximum number of assets (regardless of individual effectiveness) which can be assigned to a task.

Column ten depicts associated links (ASSOC LINK). An associated link is another task whose potential fulfillment controls the entities assignable to the current task. The link granularity (LNK GRN) is listed in column eleven. AURA provides the capability to allocate assets, in specified fractional portions, to more than one job. Column twelve shows the initial MOPP degradation value (DGR SET) for each link. The next two columns, fatigue rate (FATIG RATE) and sleep demand (SLEEP DEMND) contain values only if fatigue/sleep deprivation effects are a modeling consideration. The fatigue is the rate at which assets tire, and sleep demand is the optimal number of SLUNITs required by these personnel assets. A SLUNIT, as was mentioned previously, is a unit of measure used to represent the amount of rest associated with a personnel asset (1 SLUNIT= 1 min of fully efficient rest). The default values for fatigue rate and sleep demand are .2639 SLUNITs/min and 1,235.0 SLUNITs, respectively.

Column fifteen lists the QUIT EFF values for each link. This value is the effectiveness level (default value is 0.100 or 10%) of the link below which a substitution will not be made.

The metabolic rate for each of the links is listed in the last column. The metabolic rate default value is 250.0 W, which correlates to the energy expenditure of a person performing a task of medium difficulty. For further detail of default values and the impact of other heat stress variables, the user is referred to the Science Applications International Corporation (SAIC) report (McNally, Stark, and Ellzy 1990).

2.2.11 Link Status Table. Example 13 represents the next AURA output, the Link Status Table. For each asset type, the links (or jobs) in which the members of the asset type can serve are shown. The letter "H" stands for HOMELINK, which is the primary job of the asset in which it can immediately serve with 100% effectiveness. An entry of the form time/effectiveness/order indicates a job into which an asset can substitute in the time amount (minutes) and with the corresponding effectiveness value. The order number indicates the sequence in which the user specified the substitutes and is used to choose one particular substitute over another if all other quantities (namely versatility and effectiveness) are equal. Finally, a blank entry indicates that no substitution is possible for the link.

2.2.12 Subchains, Orlinks, Compound (CP) Links, and Chains. Examples 14–17 are reiterations of the unit's inputs for subchain elements, orlink branches, compound link parts, and chain segments. These tables are used primarily to reference the configurations of these unit tasks being modeled. Recall, subchains are used to represent the combinations of unit tasks which must be performed in conjunction to accomplish a more complex mission tasking. Orlinks are used to represent mutually exclusive choices for the accomplishment of part of the mission. Compound links are used to represent several groups tasks/jobs such that the total activity is a summation of the independent contributions of the different constructs. A chain is a collection of AURA constructs which span the activities of a unit to represent the unit mission. These tables serve to verify the correctness of the inputs by allowing the analyst to view the unit structures to ensure the intended task configurations.

(1) Elements in Each Subchain Table. The Elements in Each Subchain Table is illustrated in Example 14. The table consists mainly of two columns headed by "SUBCHAIN" and "ELEMENTS." The subchain numbers are listed under the first header, "SUBCHAIN," and are sequenced according to the order listed in the input runstream. In AURA,

LNKFG (LINK STATUS TABLE)
****

KEY: SUBT. TIME/SUBT. EFFECTIVENESS/SUBT. ORDER-READ-IN

ASSETS		1 FIREME .N	2 . FIRETE . AM	3 . CH AMM . O INSP	4 . AMMD C . LERK	5 . RECORD . CLERK	6 . RECORD . S	7 . CHECKE . RS	8 . CRANE . CHIEF	9 . CRANE .	10 . CRANE . OPER	11 . LIFT/L . DAD OP	12 . RTFL C . MIEF
1 FIREMEN	>	H	1/1.0/1										
2 FIRETEAM	>	1/1.0/1	H										
3 RECORDS	>						H						
4 CRANE	>									15/.80/2			

Example 13. <u>Link Status Table</u>.

ELEMENTS IN EACH SUBCHAIN
****

SUBCHAIN	ELEMENTS		
*1	FRKLFT6A	OPERATOR A	
*2	FRKLFT6B	OPERATOR B	
*3	FRKLFT6C	OPERATOR C	
*4	FRKLFT6D	OPERATOR D	
*5	FRKLFT6E	OPERATOR E	
*6	FRKLFT6F	OPERATOR F	
*7	FRKLFT6G	OPERATOR G	
*8	FRKLFT6J	OPERATOR J	
*9	FRKLFT4K	OPERATOR K	
*10	FRKLFT4L	OPERATOR L	
*11	FRKLFT4M	OPERATOR M	
*12	CRANE	CRANE OPER	LIFT/LOAD OP
*13	RECORD CLERK	RECORDS	

Example 14. Elements in Each Subchain Table.

subchain names are designated by a preceding "*". The second header, "ELEMENTS," contains the elements/tasks of each subchain listed horizontally. Only five elements are listed per line. Any subsequent elements for the subchain are listed on the following line.

(2) Branches in Each Orlink Table. Example 15 illustrates the Branches in Each Orlink Table. The entries in this table are denoted by the column headers "ORLINK" and "BRANCHES." The orlink numbers are listed under the first header, "ORLINK," and are sequenced to the order listed in the input runstream. In AURA, orlink names are designated by a preceding "+". The remainder of the table contains the "BRANCHES" for the orlinks. Each column contains one branch and indicates an alternative for accomplishing a task. The first branch column is composed of subchains 1–11, described in the preceding paragraph and shown in Example 14. The second branch column is composed of "USERS." Therefore, for each of the eleven orlinks listed, AURA may choose a subchain and its respective elements or a USER to accomplish the assigned task.

(3) Parts in Each Compound Link Table. The next table found in the output is the Parts in Each Compound Link Table. This table is illustrated in Example 16. The format of this table is like that of the previous two tables, in that the table consists mainly of two entries, each designated by the column headers "CP LINK" and "CP PARTS." There is only one compound link in this unit, and its name is listed under the "CP LINK" header as "!MHE." MHE stands for "materials handling equipment." In AURA, compound link names are designated by a preceding "!". The second header, "CP PARTS," contains the parts of the compound link listed horizontally. After five compound link parts are listed across the page, the sixth part starts a new line and so on until the complete compound link is graphically described. The twelve parts of this compound link are orlinks as designated by the "+" preceding the number. Compound links are each contribute slightly over 6% (.063) toward the compound link task. (Note that Example 16 only reports compound link part weights to two significant digits [i.e., .06 instead of .063]). Part No. 12 contributes the remaining 31% necessary to satisfy the compound link requirement for the parts to sum to 100%.

BRANCHES IN EACH ORLINK
++++++++++++++++++++++++

ORLINK	BRANCHES	
+1	*1	USERS A
+2	*2	USERS B
+3	*3	USERS C
+4	*4	USERS D
+5	*5	USERS E
+6	*6	USERS F
+7	*7	USERS G
+8	*8	USERS J
+9	*9	USERS K
+10	*10	USERS L
+11	*11	USERS M

Example 15. Branches in Each Orlink Table.

PARTS IN EACH COMPOUND (CP) LINK
!!!

CP LINK	CP PARTS				
!MHE	+1 (0.06)	+2 (0.06)	+3 (0.06)	+4 (0.06)	+5 (0.06)
	+6 (0.06)	+7 (0.06)	+8 (0.06)	+9 (0.06)	+10 (0.06)
	+11 (0.06)	+12 (0.31)			

Example 16. Parts in Each Compound Link Table.

(4) **Segments in Each Chain Table.** The final table of this section is entitled "Segments in Each Chain" and is shown in Example 17. The primary column header is "CHAINS." In this unit example, only one chain is being modeled. The typical AURA unit description contains only one chain; however, AURA is capable of modeling multiple chains. This chain has eight segments and the numbers 1–8 are listed under the abbreviation "SEG" in the table header. Under the number "1" in the header are the names of the seven segments of chain 1. The first, second, and fourth through sixth segments are links. The third and eighth segments are subchains as designated by the "*" preceding the subchain number. The seventh segment is a compound link designated by the "!" preceding the compound link name. If more than one chain were to be modeled, the segments of the second chain would have been listed under the number "2" in the table header.

2.2.13 Chain Plot. Example 18 is a line-printer depiction of the functional structure of a chain. This chain represents the Ammunition Supply Point (ASP), which is responsible for establishing and operating ammunition supply facilities for the receipt, storage, rewarehousing, and issue of conventional ammunition. This particular chain is composed of segments comprised of several links, a subchain, and one compound link composed of several orlinks and subchains. In this figure, different kinds of horizontal lines of characters are used to identify the functional structures: exclamation points (!) for compound links, asterisks (*) for subchains, and plus signs (+) for orlinks. The (@) signs simply serve to graphically connect the segments into a chain. Each segment represents a subtask defining a portion of the overall mission and is composed of both personnel and equipment assets.

The first two segments listed are links. The two links are each composed of one item. One has a chief ammunition inspector, and the other has an ammunition clerk. These items are listed as CH AMMO INSP and AMMO CLERK, respectively. These two segments are responsible for supervising the ammunition checkers and keeping records on how many items of ammunition are rejected and shipped out. The third segment is a subchain composed of two elements, a record clerk and records, listed as RECORD CLERK and RECORDS, respectively. This segment is responsible for keeping track of all the incoming shipments,

SEGMENTS IN EACH CHAIN
@@@@@@@@@@@@@@@

	CHAINS
SEG\	1
1	. CH AMMO INSP
2	. AMMO CLERK
3	. *13
4	. CHECKERS
5	. CRANE CHIEF
6	. RTFL CHIEF
7	. !MHE
8	. *12

Example 17. <u>Segments in Each Chain Table</u>.

```
 PLOT OF CHAIN # 1     OPERANT TIMES : (     0.0  -  INF.    )

CH  AMM
0 INSP
 @
 @
AMMO  C
LERK
 @
 @
*******
RECORD
CLERK
 @
RECORD
S
 @
 @
CHECKE
RS
 @
 @
CRANE
CHIEF
 @
 @
RTFL  C
HIEF
 @
 @
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
 @             @             @             @             @             @
 0.06          0.06          0.06          0.06          0.06          0.06
 @             @             @             @             @             @
  +++++++++++   +++++++++++   +++++++++++   +++++++++++   +++++++++++   +++++++
 @       @     @       @     @       @     @       @     @       @     @
*******  USERS *******  USERS *******  USERS *******  USERS *******  USERS *******
 @       A     @       B     @       C     @       D     @       E     @
FRKLFT   @     FRKLFT  @     FRKLFT  @     FRKLFT  @     FRKLFT  @     FRKLFT
6A       @     6B      @     6C      @     6D      @     6E      @     6F
 @       @     @       @     @       @     @       @     @       @     @
OPERAT   @     OPERAT  @     OPERAT  @     OPERAT  @     OPERAT  @     OPERAT
OR A     @     OR B    @     OR C    @     OR D    @     OR E    @     OR F
 @@@@@@@@@     @@@@@@@@@     @@@@@@@@@     @@@@@@@@@     @@@@@@@@@     @@@@@
 @             @             @             @             @             @
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
 @
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

Example 18. Chain Plot.

```
         @                  @                  @                  @                 @
         0.06               0.06               0.06               0.06              0.06
         @                  @                  @                  @                 @
++++       +++++++++++        +++++++++++        +++++++++++        +++++++++++       +++++++++++
  @      @         @        @         @        @         @        @         @       @         @
USERS    *******   USERS    *******   USERS    *******   USERS    *******   USERS   *******   USERS
F         @        G         @        J         @        K         @        L        @        M
  @      FRKLFT     @       FRKLFT     @       FRKLFT     @       FRKLFT     @      FRKLFT     @
  @      6G         @       6J         @       4K         @       4L         @      4M         @
  @       @         @        @         @        @         @        @         @       @         @
  @      OPERAT     @       OPERAT     @       OPERAT     @       OPERAT     @      OPERAT     @
  @      OR G       @       OR J       @       OR K       @       OR L       @      OR M       @
@@@       @@@@@@@@@          @@@@@@@@@          @@@@@@@@@          @@@@@@@@@         @@@@@@@@@
          @                  @                  @                  @                 @
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
  @
 0.31
  @
*******
  @
 CRANE
  @
 CRANE
 OPER
  @
 LIFT/L
 OAD OP
@@@@@@
```

Example 18. Chain Plot. (continued)

outgoing shipments, and other types of pertinent records. The next three segments are links with each composed of one item. These three items are ammunition checkers, a crane chief, and a rough terrain forklift chief. These items are listed as CHECKERS, CRANE CHIEF, and RTFL CHIEF, respectively. These three segments are responsible for inspecting the ammunition for defects, supervising the crane operations, and supervising the forklift operations.

The seventh segment is a compound link, which is responsible for loading trucks with ammunition. This compound link is composed of twelve parts. The first eleven are orlinks, each composed of two branches. The first branch contains a forklift and a forklift operator which are elements of subchains. The second branch of each orlink contains manual loading personnel (USERS). (See also Examples 14 and 15 and their respective descriptions for more explanation.) The eleven forklifts are listed as FRKLFT plus one of the following number-letter combinations: 6A, 6B, 6C, 6D, 6E, 6F, 6G, 6J, 4K, 4L, and 4M. Similarly, the forklift operators are listed as OPERATOR, plus one of these letters: A, B, C, D, E, F, G, J, K, L, and M. In this particular example, each is responsible for a different category of ammunition. The loading personnel are listed as USERS and are followed by the same letters as the operators. These 11 orlinks are responsible for loading the trucks with the majority of the ammunition stacks. This task can be accomplished mechanically (with forklifts) or manually (by operators) in case of forklift failure. Each of these orlinks is assigned an independent weighted contribution value of 0.063. When operational, each of these orlinks contributes a maximum of 6.3% to the overall effectiveness of the task represented by the compound link. For this chain plot, this value is listed only to two decimal places to the right of the decimal point (0.06) and rounded up to two significant digits.

The twelfth part of this compound link is a subchain (denoted by asterisks) composed of three elements: a crane, a crane operator, and a lift/load operator. These elements are listed as CRANE, CRANE OP, and LIFT/LOADOP, respectively. This subchain is responsible for loading the heavier ammunition stacks onto the trucks. The contribution of this part can be at most 0.307, which has been rounded to 0.31 on the plot.

The chain plot is primarily used as a quick reference as to the overall organization of unit tasks. In the analysis of unit effectiveness it is often necessary to assess the weak segment

or choke point. This chain plot provides a graphic display of unit constructs in the order in which the code will follow to determine the weak segment or choke point. If two choke points occur, the one encountered first will be identified in the Weak Link Table. (See "Reconstitution" in the Intermediate Results section of this report.)

2.2.14 Deployment. Example 19 summarizes the deployment parameters for posture and location defined for each AURA asset in the input runstream. The assets in the deployment table are printed according to the sequential order of each point.

The first column of the Deployment Table is the target point. AURA internally sorts all target points and reports the assets (and their corresponding parameters) deployed at each target point. The second column contains the identification number assigned to each asset based upon the input order of the input runstream. Column three contains the alphanumeric name of the asset. An asterisk preceding the asset name indicates a personnel asset. Column four represents the identification number of the link/job associated with each asset. The link numbers are assigned by AURA based upon the order that the links are input. Columns five and six represent the Cartesian grid coordinates of the target point. Column five is the X coordinate, and column six represents the Y coordinate. The next column entry represents the number of assets which are deployed at the target point. A minus sign preceding the value in this column signifies that the assets at this target point are DUMMYLINKs. DUMMYLINKs are jobs that may be deployed but have no primary assets associated to them. DUMMYLINKs may be used if the scenario warrants the use of additional or alternative methods to complete tasks within the mission. Columns eight through ten report the kill criteria (KC) for conventional, nuclear, and chemical environments, respectively. The user is referred to the AURA Input Manual for a detailed discussion of these parameters (Klopcic, Sheroke, and Price 1990). Columns eleven through thirteen represent the posture code number associated with each lethality type (i.e., conventional, nuclear, and chemical, respectively). In AURA, an asset may be described to be in one of several postures such as in the open, in a foxhole, in a tank, etc. AURA can assess weapon effects criteria based upon the asset's battlefield posture. The default asset posture is one which represents an "in the open" battlefield posture and can be modified via the DEPLOYMENT command. AURA provides the capability for the user to specify postures for any battlefield environment scenario. Some example postures used in AURA analyses have been "behind a building," "in

THIS SECTION PRINTED ONLY WHEN THERE IS AN ALTERNATIVE DUCK OR MOPP POSTURE BEING MODELED

DEPLOYMENT
* * * * * * * * * *

TGT PNT	ID	ASSET	LNK ID	X COORD.	Y COORD.	NUMBER AT TGT	CONV. KC.	NUKE KC	CHEM. KC.	CONV PSTR	NUKE PSTR	CHEM PSTR	DUCK TIME	ALT. PSTR	ALT. NUCVR	ALT. MOPP	MOPP TIME
1	46	* CHECKERS	7	1549.6	48.0	1.00	1	1	2	1	1	0	0.500	2	1	4	0.500
2	60	* MAINT STAFF	54	1569.4	53.7	3.00	1	1	4	1	1	0	0.500	2	1	4	0.500
3	35	RADIO	54	1546.1	54.2	1.00	1	1	1	1	1	0	0.500	2	1	4	0.500
4	81	* OPERATOR L	33	1546.1	55.1	1.00	1	1	8	1	1	0	0.500	2	1	4	0.500
5	81	* OPERATOR L	33	1546.1	55.1	1.00	1	1	7	1	1	0	0.500	2	1	4	0.500
6	25	* USERS L	44	1547.8	56.8	2.00	1	1	2	1	1	0	0.500	2	1	4	0.500
7	14	FRKLFT4	22	1547.8	56.8	1.00	1	1	1	1	1	0	0.500	2	1	4	0.500
8	88	* DUMMY SERVC	49	1519.1	95.3	-1.00	1	1	2	1	1	0	0.500	2	1	4	0.500
9	64	DROP SIDES	54	1519.1	95.3	1.00	1	1	1	1	1	0	0.500	2	1	4	0.500

Example 19. Deployment Table.

a dense forest," and "in a tent." These postures must be assigned a posture code value and associated criteria by the knowledgeable user.

Columns fourteen through eighteen are only printed when alternate duck or MOPP postures are being specified within the input runstream. Column fourteen, prefaced by the label "DUCK TIME," reports the time required for the asset to change from its original to its alternate posture. Duck time is an analogy to the natural reaction of a person to "take cover" or duck upon the detonation of a warhead. Duck time only refers to the posture changes for a conventional or nuclear scenario. It is important to understand the distinction between column fourteen (DUCK TIME) and column eighteen (MOPP TIME). DUCK TIME reports the time required to change postures for conventional or nuclear environments while MOPP TIME only reports the time required for posture change associated with a chemical scenario. Columns fifteen through seventeen report the alternate postures for conventional, nuclear, and chemical as defined by the values specified in the DEPLOYMENT command.

2.2.15 Deployment Plot. Example 20 is a line-printer plot of an example unit deployment. The deployment plot depicts the location of all assets deployed in the unit.

Asset group items are represented by their two-digit identification (ID) numbers which have been assigned by AURA and are determined by the order that the assets are sequenced in the input runstream. Asset ID numbers 1–9 are represented by a preceding zero. The deployment plot is mapped to an inverted Cartesian coordinate system in which the Y axis is the horizontal axis and the X axis is the vertical axis. If two or more assets are deployed at the same target point, they are shown adjacent to each other in the plot. For this reason, the deployment plot is not a scaled drawing of the unit and should only be used as a quick check of the data. (Note: Utility graphics programs such as AURATEK [Swoboda 1991] exist to produce scaled drawings of AURA inputs.) These numbers and their corresponding assets are shown in Example 19, the Deployment Table.

The deployment plot also indicates the incoming fire direction and wind direction. In this example, the incoming fire direction is from east to west and is shown by the path from the AAs toward the BBs. The wind direction is also from east to west and is described by the path shown by the line from YY to ZZ.

```
DEPLOYMENT    Y  INTERVAL = 600.  X  INTERVAL =   50.    INITIAL  INCOMING  DIRECTION  FROM  AA  TO  BB     DOWNWIND  FROM YY  TO  ZZ
**************  ******************** ********************  ************************************************  ******************************

              0.                          600.                       1200.                      1800.                     2400.                         3000.
              v                           v                          v                          v                         v                             v

 400. >                                                                        AA
      >                                                                    4670 48433752353566354537353 3
      >                                                                    3516854937404036360336675036
      >                                                                    7005864237406984446803405151
      >                                                                     8535045336
      >                                                                       YY
      >                                                                       AA
      >                                                                       YY
      >                                                                       AA
      >                                                                       YY
 900. >                                                        37             39AA         6479
      >                                      28                               27YY         2379
      >                                                                       AA           12
      >                                                                       YY                 375540
      >                                                                       AA                 4056
      >                                                                       YY                 5436
      >                                                                       AA
      >                                                                       YY
      >                                                        3506           AA
      >                                                        7117           8863         858537
1400. >                                                        71            856204        860462
      >                                                        46            8538          356488
      > 463525642480               357207                                    8635
      >   811462138088                7218                01                  YY
      >   8188463565                  46                  02                  AA
      >   6062386362                                                          YY
      >     8862                                                              AA
      >     6338                                                              ZZ
      >                                                  37                   BB
1900. >               33                                 62                   ZZ
      >                                              62 3546   7546           BB     37
      >                                              88 742088 3510          4682    62
      >                                                 740962 7521          8215
      >                             3863                  64                 3526
      >                             8862                                      BB
      >                             37                4676                    ZZ
      >               4673                            3522                    BB
      >               7319                            7611                    ZZ
      >               3508                                                    BB
      >                                                                       ZZ
```

Example 20. Deployment Plot.

```
       >
2400.  >                  8685     BB
       >                  3504     ZZ
       >                  85       BB      5658
       >                                   ZZ       365737403136798246856970737681 7275
       >           8585    37      BB  60607740623734322980456085847174798273
       >           8604    6433    ZZ  38356088374130357681546286707275807174
       >           35              BB  637762633859476037416168
       >                           ZZ  8862358604
       >                           BB
2900.  >                           ZZ  87
       >                           BB
                                   ZZ
```

Example 20. Deployment Plot. (continued)

As referenced before, the Y axis is the horizontal axis, and the X axis is the vertical axis. This is depicted in the first line of the plot, after the header "DEPLOYMENT," as "Y INTERVAL = 600. X INTERVAL = 50." "Y INTERVAL = 600." means that each greater than sign on the Y axis is displayed in increments of 600. Likewise, "X INTERVAL = 50." signifies that each greater than sign on the X axis is displayed in increments of 50. Also stated in line 1 is the incoming fire direction and wind direction, depicted as "INITIAL INCOMING DIRECTION FROM AA TO BB DOWNWIND FROM YY TO ZZ." The next line displays the Y axis, and the first column displays the X axis. In Example 20, the target point (463,1506) shows a dense asset population. This list of numbers, 484337523535663545373533, is composed of the two-digit ID numbers 48, 43, 37, 52, 35, 35, 66, 35, 45, 37, 35, and 33. The deployment plot produced in this example would be interpreted in the following manner: move supervisor, ammunition technician, trailer, van5ton, radio, radio, ASP platoon leader, radio, record clerk, trailer, radio, and guard. The deployment table (described in the previous section) was used to identify these numbers with their corresponding assets. (Note: not all identification numbers in the unit are shown in Example 19).

2.3. Intermediate Results.

2.3.1 Nuclear/Chemical Dosage Accumulation Table. The Dosage Accumulation Table reports the nuclear or chemical dosages received by personnel assets. In AURA, the dosages received are accumulated with respect to the target point. That is, the personnel assets receive the same dosage as the target point. The three values reported by the Dosage Accumulation Table are as follows: the amount of nuclear or chemical dosage received, the time that the dosage was received, and the resiliency (or hardness factor) to the dosage associated with each individual. In a nuclear scenario, the dosage received is reported in units of rads (cGy), while chemical dosages will be reported in milligrams minute per cubic meter (mg.min/m^3) (vapor agent) or milligrams per square meter (mg/m^2) (percutaneous agent). The hardness factor is a number between the values of 0.0 and 1.0, selected at random by AURA, which is used to indicate the resiliency of an individual affected by a specified dose. The inclusion of personnel hardness values provides a modeling tool to represent the variance in how personnel are affected by nuclear or chemical dosages. The greater the hardness value, the less resilient the asset is toward the nuclear/chemical dosage. For example, if a person is assigned a hardness value of .57, the total dosage assigned to this person will be calculated as the product of .57 and dosage, which means that this person

will receive 57% of the dosage. This information is used by the analyst to determine which assets will be more susceptible to the doses received.

Example 21a illustrates the Dosage Accumulation Table for a nuclear scenario. The reporting time in this case is 30.0 min into the scenario, shown by the string "DOSAGE BINS AT TIME 30.0." The data reported in the table are as follows: the asset group identification number, the number of assets in that asset group, and the dosage information. In this example, there are two people in asset group No. 16 who received 340 rads at 8 min into the scenario, and their hardness value is 0.263.

Example 21b illustrates the Dosage Accumulation Table for a chemical scenario. The reporting time in this case is 20.0 min into the scenario, shown by the string "DOSAGE BINS AT TIME 20.0." The data reported in the table are as follows: the asset group identification number, the number of assets in that asset group, and the chemical dosage information. Assuming that the agent is a vapor in this example, the two assets in asset group No. 19 received a vapor dosage of 1.4 $mg.min/m^3$ at 5 min into the scenario. The hardness value associated with these personnel is 0.870.

2.3.2 Casualties. The casualty outputs, illustrated in Examples 22–27, are printed as a result of the declaration of the CASUALTIES,ON option within the input runstream. This output option causes a report of all casualties, contaminations, early transient incapacitation (ETI) episodes, and expenditures as they occur. In addition, the use of the CASUALTIES option also causes reports of equipment reliability failures and heat stress losses. If the WEAPON,ON option has not been issued, the CASUALTIES option also describes incoming warheads which cause immediate casualties. (For an explanation and illustration of this output, the user is referred to the WEAPON section of this report.) Output for the CASUALTIES option differs depending on the environment being modeled (i.e., conventional, chemical, or nuclear). Examples of the various outputs, produced by the CASUALTIES,ON option, are given and explained in the following paragraphs.

The Casualty Table resulting from a conventional run (illustrated in Example 22) begins by listing the asset group identification number and the corresponding link with which the asset is associated. Next, the probability of damage (PKF) is reported. PKF is the total probability of

(NUCLEAR)

DOSAGE BINS AT TIME 30.00

```
**********************************

ID   NUMBER AT   ( DOSE / TIME - OF - DOSE / HARDNESS ) . . . .
**************************************************************
16      2.00       ( 340.0 /   8.0 / 0.263 )
17      1.00       (     0. /   0.  / 0.471 )
18      1.00       (     0. /   0.  / 0.054 )
19      1.00       (     0. /   0.  / 0.870 )
```

(a) Nuclear

(CHEMICAL)

DOSAGE BINS AT TIME 20.00

```
**********************************

ID   NUMBER AT   ( DOSE / TIME - OF - DOSE / HARDNESS ) . . . .
**************************************************************
16      2.00       (   1.4 /   5.0 / 0.870 )
17      1.00       (    0. /   0.  / 0.263 )
18      1.00       (    0. /   0.  / 0.672 )
19      1.00       (    0. /   0.  / 0.107 )
```

(b) Chemical

Example 21. Nuclear and Chemical Dosage Accumulation Table.

CASUALTIES
****

(Conventional)

```
*** CASUALTY ***  ID:   9  IN  LNK   16.  PKF = 1.00  PK*# AT TGTPT   96 (   150.0,   110.0 )  =  0.34
*** CASUALTY ***  ID:  11  IN  LNK   17.  PKF = 1.00  PK*# AT TGTPT   97 (   150.0,   110.0 )  =  1.00
*** CASUALTY ***  ID:  10  IN  LNK   18.  PKF = 1.00  PK*# AT TGTPT   98 (   150.0,   110.0 )  =  1.00
*** CASUALTY ***  ID:  12  IN  LNK   19.  PKF = 1.00  PK*# AT TGTPT   99 (   150.0,   110.0 )  =  1.00
*** CASUALTY ***  ID:   5  IN  LNK   20.  PKF = 1.00  PK*# AT TGTPT  100 (   150.0,   110.0 )  =  1.00
```

Example 22. Casualties - Conv.

light, medium, and heavy damage (otherwise referred to as inclusive damage levels) for the specified asset group. In the first line of Example 22, the PKF for asset group 9 is 1.00. That is, the total probability of damage for asset group No. 9 is 100%. The remaining information reported pertains to the number of assets lost within the given asset group. Probability of kill is described with respect to the target point and corresponding coordinates specified for each asset group in the deployment section of the input runstream. The first line of Example 22 shows that asset group No. 9 at target point 96 (which has the coordinates 150.0, 110.0) lost a total of 0.34 members.

When modeling a chemical attack, the CASUALTIES,ON option results in several different outputs, some of which pertain only to equipment assets while others apply only to personnel. The first group of casualty results, described in the following paragraph, consists of three types of outputs relating to equipment contamination. The subsequent two paragraphs contain the detailed description of the outputs relating to the effects of chemical munitions on personnel.

The first contamination output, shown in Example 23a, lists the time (in minutes) at which the contamination occurred and the number of items contaminated by the chemical hazard. In AURA, the criterion for being considered contaminated is based on the minimum level of contamination specified in the PRETOX run (Hindman 1990). As in the case of a conventional scenario, the casualty report for each asset group is given with respect to the associated target point. The target point and corresponding coordinates are the next items reported in the output. The next data reported is the HOME ID (i.e., HOMELINK identification number) of the affected target point. The last item reported is the evaporation time (EVAP TIME). Evaporation time is the clock time at which the chemical contaminate will evaporate to the minimum contamination level specified by the user in NUSSE (Saucier 1986). In the event that a previously contaminated item is recontaminated, a message, following the output described above, will be printed (see Example 23b). This message reports the number of assets that have been recontaminated followed by the phrase "PREVIOUSLY CONTAMINATED ITEMS WERE RECONTAMINATED." AURA reports the recontamination status to describe why some assets, whose contamination should have evaporated, continue to have a contaminated status. In other words, additional contamination received by an asset

```
                              CASUALTIES
                              *************

( Chemical - contamination output )

AT TIME 10980.2, 1.00 ITEMS AT TGT PT 158 ( 2706.8, 1619.0 ) [ HOME ID = 38] WERE CONTAM. EVAP TIME = 13808.54

AT TIME 10980.2, 1.00 ITEMS AT TGT PT 159 ( 2706.8, 1619.8 ) [ HOME ID = 63] WERE CONTAM. EVAP TIME = 13808.36

AT TIME 10980.2, 1.00 ITEMS AT TGT PT 165 ( 2710.4, 1643.3 ) [ HOME ID = 35] WERE CONTAM. EVAP TIME = 13903.31
```

(a)

```
1.35 PREVIOUSLY CONTAMINATED ITEMS WERE RECONTAMINATED
0.89 PREVIOUSLY CONTAMINATED ITEMS WERE RECONTAMINATED
3.45 PREVIOUSLY CONTAMINATED ITEMS WERE RECONTAMINATED
```

(b)

```
BEFORE EVENT AT TIME   1080.2   JUNK FROM ID 23   WAS EVAPORATION DECONNED.
BEFORE EVENT AT TIME   1080.2   JUNK FROM ID 24   WAS EVAPORATION DECONNED.
BEFORE EVENT AT TIME   1080.2   JUNK FROM ID 24   WAS EVAPORATION DECONNED.
```

(c)

Example 23. Casualties - Chem 1.

which has already begun the decontamination process will increase the time necessary for that asset to be decontaminated.

The CASUALTIES,ON option will also cause a report of assets that have been decontaminated. This portion of output (illustrated in Example 23c) lists the time in the simulation at which the asset was decontaminated. The remainder of this output is preceded by the phrase, "JUNK FROM ID," which introduces the group identification number for the decontaminated asset. The word "JUNK" refers to the pool of contaminated assets. The phrase, "WAS EVAPORATION DECONNED," completes this portion of output. Evaporation deconned means that sufficient time has elapsed so that the effects of the contaminating agent have evaporated. Once the previously contaminated assets become evaporation deconned, they are ready to be used and are reassigned to the pool of available assets.

Another type of chemical casualty output is the dose-time casualty report. In the context of this table, a dose-time casualty is defined as an individual who has received a lethal dose, and for which the time required for the dosage to take effect has elapsed. The corresponding output (illustrated in Example 24a) begins by listing the time at which the asset became a casualty. Next, the group identification number followed by the total number of casualties for the affected asset group is listed. The last items printed are the cumulative dose (DOSE), the dosage multiplier (MULT) (see T.K.C. mnemonic in the AURA Input Manual for more information), and the time (TIME) over which the dosage was received.

The last type of casualty possible in a chemical scenario is an immediate casualty. This type of casualty is incurred when a personnel asset receives sufficient toxic dosage over a short time period to be considered a casualty based on a specified maximum dose criterion. Example 24b illustrates the output for immediate casualties which also begins by listing the time at which the casualty occurred followed by the identification number of the affected asset group. The final entry is the total immediate casualties received by the asset group.

For nuclear scenarios, there are several types of outputs reported for the CASUALTIES,ON option. The first way in which a nuclear casualty may be reported is with respect to the asset's susceptibility to the various environments created by a nuclear weapon

CASUALTIES
****

(Chemical - casualty output)

```
AT TIME   980.0  ID 34 TOOK 2.58 DOSE - TIME CAS.  DOSE , MULT , TIME  =  1.54   1.38   750.00
AT TIME   980.0  ID 35 TOOK 1.02 DOSE - TIME CAS.  DOSE , MULT , TIME  =  0.99   1.20   750.00
AT TIME  1080.2  ID 48 TOOK 0.58 DOSE - TIME CAS.  DOSE , MULT , TIME  =  1.33   0.87   900.00
AT TIME  1080.2  ID 49 TOOK 0.89 DOSE - TIME CAS.  DOSE , MULT , TIME  =  0.63   1.00   900.00
```

(a)

```
AT TIME  1500.3   ID  23  WAS ASSESSED  1.75   IMMED.  CASUALTIES
AT TIME  1500.3   ID  24  WAS ASSESSED  0.52   IMMED.  CASUALTIES
AT TIME  1500.3   ID  25  WAS ASSESSED  0.20   IMMED.  CASUALTIES
AT TIME  1500.3   ID  28  WAS ASSESSED  4.31   IMMED.  CASUALTIES
```

(b)

Example 24. Casualties - Chem 2.

(i.e., blast [BLST], electromagnetic pulse [EMP], neutron fluence [NF] (sometimes referred to as transient radiation effects on electronics), and thermal fluence [THRM]). Effects from these four environments are reported for equipment. Of these four environments, personnel are only susceptible to the effects of blast and thermal fluence; consequently, only parameters relating to these environments are reported for personnel assets. (It should be noted that personnel are also susceptible to radiation. When using the CASUALTIES,ON option, radiation effects are reported in separate outputs, namely the dose-time casualty and immediate casualty outputs. These outputs are illustrated and explained below.) The output generated (illustrated in Example 25) begins by listing the asset group identification number, followed by the link (LNK) in which the asset group is deployed. Next, the probability of kill (PK) for assets of this type is listed. Following the PK is the probability of kill multiplied by the number of assets (PK*number) deployed at the specified target point.

When the casualty reported is an equipment asset (i.e., damaged equipment), the probability of survival with respect to each environment is listed in the following form: (environment "dosage"/probability of survival) for blast, electromagnetic pulse, neutron fluence, and thermal fluence, respectively. The units for the various environments are psi^2 sec, volts per meter (V/m), neutrons/cm^2, and cal/cm^2, respectively. In Example 25, asset group No. 4 of link No. 9 has the probability of kill (PK) equal to 0.98. The probability of kill times the number of assets of this asset type at target point No. 2, with the coordinates 1356.0 and 1739.5, is 0.98. (In this case, there is only one asset of this type deployed at target point No. 2 since the PK for this asset group No. 9 is the same as the value of the PK multiplied by the number of assets at the target point [PK*#].) Following this data, the probability of survival with respect to the various environments is reported. In Example 25, the blast, electromagnetic pulse, and thermal fluence level are reported as 0.00E+00. This simply means that no effects from these environments were calculated for this asset. However, in the case of the neutron fluence environment, the effect received was 2.52E+12 (or 2.52 X 10^{12}) neutrons/cm^2. Consequently, in this environment, the asset only has a 0.02 (2%) chance of survival.

In the case of personnel assets, the probability of kill with respect to the blast and thermal environments is reported. In Example 25, the fourth entry is read as follows: asset group No. 17 of link No. 9 has the probability of kill equal to 1.00 (100%). The probability of kill

```
                              CASUALTIES
                              **************

 ( Nuclear )

** CAS ** ID: 4, LNK   9.  PK = 0.98  PK*# AT TGTPT    2 (  1356.0 ,  1739.5 ) = 0.98
              ENVS / PSURV : BLST , EMP , NF , THRM = ( 0.00 E + 00 / 1.00)  (0.00 E + 00 / 1.00)  ( 2.52 E + 12 / 0.02 )  (0.00 E + 00 / 1.00 )

** CAS ** ID: 4, LNK   9.  PK = 1.00  PK*# AT TGTPT    3 (  1420.0 ,  1491.0 ) = 1.00
              ENVS / PSURV : BLST , EMP , NF , THRM = ( 0.00 E + 00 / 1.00)  (0.00 E + 00 / 1.00)  ( 1.67 E + 13 / 0.00 )  (0.00 E + 00 / 1.00 )

** CAS ** ID: 4, LNK   9.  PK = 0.84  PK*# AT TGTPT    4 (  2449.5 ,  1278.0 ) = 0.84
              ENVS / PSURV : BLST , EMP , NF , THRM = ( 0.00 E + 00 / 1.00)  (0.00 E + 00 / 1.00)  ( 1.82 E + 12 / 0.16 )  (0.00 E + 00 / 1.00 )

              .
              .
              .

** CAS ** ID: 17, LNK   9.  PK = 0.84  PK*# AT TGTPT    10 (  1349.0 ,  1292.2 ) = 2.00

                                         PK / ENV. : BLST =  0.26 /  19.14    THERM = 1.00 /  76.48
```

Example 25. Casualties - Nuc 1.

multiplied by the number of personnel of this asset type at target point 10 with the coordinates 1349.0 and 1292.2 is 2.00. (In other words, there are two personnel assets deployed at this target point.) The probability of kill due to the blast received (19.14 psi^2 sec) is 0.26 (26%). The probability of kill with respect to the level of thermal fluence received (76.48 cal/cm^2) is 1.00 (100%). From this information, the analyst can determine that thermal fluence was the dominant effect. The third environment to which personnel are susceptible is radiation which is reported via the DOSE output option. Casualties resulting from these dosages are controlled by the CASUALTIES,ON option.

Example 26a depicts the nuclear scenario casualty report for an accumulated dose-time casualty. This type of casualty, as the name implies, results when a personnel asset receives a sufficient nuclear dose (rads) to cause death within a period of time, and the time period has elapsed. The output for this type of casualty first lists the time into the simulation at which this casualty occurred. Next, the asset group identification number is reported, followed by the total number of resulting casualties for this asset group. The final entries for this type of casualty are the accumulated dose (in rads) and the elapsed time (in minutes). In Example 26a, it is shown that at time 105.0 min into the simulation, 0.48 members of Asset Group 46 accumulated a lethal dose of 3,232.85 rads, which was received 15 min earlier.

Immediate casualties, shown in Example 26b, is another type of casualty that is reported in a nuclear scenario. An immediate nuclear casualty results when a person receives 8,000 rads or more. The output for this type of casualty reports the time at which the casualty was assessed, the identification number of the affected asset group, and the total number of casualties assessed that asset group. Each line of output for immediate casualties ends with the statement, "OVER 8,000. rads." The value "8,000" is an AURA default which can be altered by using the MAX DOSE command which is an optional DOSE PARAMETERS command. For further information regarding the use of these commands, the user is referred to the AURA input manual (Klopcic, Sheroke, and Price 1990).

Another casualty-producing nuclear effect occurs when an asset is suffering from the effects of early transient incapacitation (ETI). The resulting output for this type of casualty is illustrated in Example 26c. ETI occurs when an individual receives enough radiation to induce

CASUALTIES
****

(Nuclear)

```
AT TIME 105.0, ID 46 TOOK 0.48 ACCUM. DOSE - TIME CAS. DOSE, TIME = 3232.85 15.00
AT TIME 105.0, ID 46 TOOK 0.40 ACCUM. DOSE - TIME CAS. DOSE, TIME = 5838.95 15.00
AT TIME 120.0, ID 19 TOOK 0.87 ACCUM. DOSE - TIME CAS. DOSE, TIME = 6065.83 30.00
```

(a)

```
AT TIME 105.0, ID 33 WAS ASSESSED 3.33 IMMED. CASUALTIES. (OVER 8000. RADS )
AT TIME 105.0, ID 62 WAS ASSESSED 0.07 IMMED. CASUALTIES. (OVER 8000. RADS )
AT TIME 105.0, ID 85 WAS ASSESSED 1.32 IMMED. CASUALTIES. (OVER 8000. RADS )
```

(b)

```
DURING REALLOC. AT TIME 105.0, 1D 19 HAD 0.87 MEMBERS DOWN DUE TO ETI
DURING REALLOC. AT TIME 105.0, 1D 23 HAD 0.98 MEMBERS DOWN DUE TO ETI
DURING REALLOC. AT TIME 105.0, 1D 24 HAD 0.96 MEMBERS DOWN DUE TO ETI
```

(c)

Example 26. Casualties - Nuc 2.

a coma for a period of time. During this time, the victim cannot function and is not available to the unit. ETI episodes are reported at each reconstitution time. The first value reported is the time into the simulation at which the episode occurred. The identification number of the affected asset group along with the total number of members of that asset group unconscious due to ETI are the remaining data provided by this output.

The CASUALTIES,ON option also produces a report of expenditures as they occur throughout the simulation. This output applies to assets that are expendable by time and not to assets which are expendable by repair completion. For further information on expendables, the user is referred to the AURA input manual (Klopcic, Sheroke, and Price 1990). The expenditure report gives the number of assets removed from the pool of available assets for the given asset group. The first entry for the expenditure output is the time at which the asset was expended. Next, the total number of assets expended and the group identification number are reported. This output is illustrated in Example 27a.

When modeling HEAT STRESS, the CASUALTIES,ON option will also report heat stress casualties. Heat stress casualties are personnel assets which are suffering from the effects of heat stress. The user is referred to the SAIC report on heat stress for a comprehensive description of an analysis using AURA's heat stress methodology (McNally, Stark, Ellzy 1990). This output, illustrated in Example 27b, provides the following information: the number of assets (in the affected asset group) that are experiencing heat stress, the asset group identification number, target point location, link identification number, as well as the core temperature and critical temperature of the asset. For instance, as reported in Example 27b, at a time of 5.0 min prior to the scenario, 9.55 elements from asset group No. 23 of link No. 23, located at target point 18 had core temperatures of 38.5° C (101.3° F) and critical temperatures of 40.6° C (105.1° F). Heat stroke normally occurs when the internal core temperature of the human body exceeds 41.1° C (106° F). In AURA, personnel suffering from heat stroke are considered lethalities. (For further information on the calculation of core and critical temperatures, see AURA Heat Stress report [Klopcic 1989].)

The use of the RELIABILITY OF WEAPONS command in conjunction with the CASUALTIES,ON option causes a report of reliability failures to be printed. This output lists the number of failures, identification number, and target point location for the asset group.

```
                              CASUALTIES
                              **********
(All scenarios - expenditures)

BEFORE EVENT AT TIME 500.0   AMOUNT   6.65   FROM ID  34   WAS EXPENDED
BEFORE EVENT AT TIME 500.0   AMOUNT   2.03   FROM ID  35   WAS EXPENDED
BEFORE EVENT AT TIME 900.0   AMOUNT   1.87   FROM ID  41   WAS EXPENDED
BEFORE EVENT AT TIME 900.0   AMOUNT   3.35   FROM ID  39   WAS EXPENDED
```

(a)

```
(heat stress)

** HEAT CAS ** BEFORE TIME 5.0.  9.55 ELEMENTS FROM ID: 23 AT TGTPT 18 (LINK 23 ) TCOR TCRIT = 38.5   40.6
** HEAT CAS ** BEFORE TIME 5.0.  2.03 ELEMENTS FROM ID: 24 AT TGTPT 20 (LINK 24 ) TCOR TCRIT = 38.7   40.8
** HEAT CAS ** BEFORE TIME 5.0.  4.79 ELEMENTS FROM ID: 25 AT TGTPT 21 (LINK 24 ) TCOR TCRIT = 38.3   40.9
```

(b)

```
(reliability failures)

>>> 0.77  UNITS FROM ID 20 AT TGT . PT. 27 HAD A LIGHT FAILURE AT TIME 180.0 <<<
>>> 2.03  UNITS FROM ID 19 AT TGT . PT. 16 HAD A DEAD  FAILURE AT TIME 180.0 <<<
>>> 1.26  UNITS FROM ID 17 AT TGT . PT. 22 HAD A LIGHT FAILURE AT TIME 180.0 <<<
```

(c)

Example 27. Casualties - Miscellaneous.

Also reported is the type of failure (i.e., light, medium, or dead) and the time of failure. In Example 27c, 0.77 units from asset group No. 20, located at target point No. 27, had a light reliability failure at 180.0 min into the simulation.

2.3.3 Deployment Dump Table. Example 28 shows the output produced when the DEPDMP, ON command has been specified as an output option in the input runstream. This table reports the exact location of each asset in terms of which target point (TGTPNT) and job/link (JTGTLK) the asset resides in at the time specified. Reported for every target point is the target point number, the number of the link at that target point, the asset group identification number, and the number of people in the asset group. The target point number, link number, and asset group number are assigned by AURA with respect to the input order of the data. In Example 28, at a time of 5 min into the scenario, target point No. 1 contains job/link No. 28 which is performed by the one person in asset group No. 1. The primary usage of this table is to provide the capability to monitor the dynamic allocation/reallocation process during the simulation.

2.3.4 Dosage Table. The Dosage Table reports all nuclear or toxic dosages as received by personnel assets. In AURA, dosages are accumulated with respect to target point. That is, all personnel assets at each target point receive the dosage amount received by the target point. The Dosage Table consists of the various parameters pertaining to the dosage received by personnel at the affected target point. This information is generated by the inclusion of the output option DOSE,ON in the input runstream. The Dosage Tables generated for chemical and nuclear runs differ considerably; therefore, an illustration and explanation is provided for each scenario. Examples 29 and 30 illustrate Dosage Tables generated for chemical and nuclear scenarios, respectively.

The first three entries in the chemical Dosage Table are the time (units designated by user, in this case seconds) at which the dosage was received, the number of personnel affected, and the associated target point number. The target point is given as a number which when cross-referenced with the Deployment Table gives the coordinates and other data specified for that asset. Following the target point is the entry FGHM. FGHM identifies the homelink asset identification number at that target point. The next entry reports the MOPP for each asset group at the time the dosage was received. The MOPP may be either ORIG

*** DEPLOYMENT AT TIME*** 5.0	TGTPNT	JTGTLK	ASSET(NUMBER)
	1	28	1(1.00)
	2	70	53(1.00)
	3	29	2(1.00)
	5	1	3(1.00)
		.	
		.	
		.	
		.	
	114	39	23(1.00)
	115	40	29(1.00)

WHERE:

TGTPNT is the number of the target point (assigned by AURA)

JTGTLK is the number of the link at TGTPNT (assigned by AURA)

ASSET is the number of the asset group (assigned by AURA)

NUMBER is the number of assets in the asset group

Example 28. Deployment Dump Table.

```
DOSAGE TABLE
***************

AT TIME 600.0,  1.00 PERS AT TGT PT 161 (FGHM=  62) IN ORIG MOPP PSTR RCV PRC LIQ. SINCE PREV RCNST, TOTAL DOSE = 1.53

AT TIME 600.0,  1.00 PERS AT TGT PT 164 (FGHM=  60) IN ORIG MOPP PSTR RCV PRC LIQ. SINCE PREV RCNST, TOTAL DOSE = 1.25

AT TIME 600.0,  1.00 PERS AT TGT PT 166 (FGHM=  86) IN ORIG MOPP PSTR RCV PRC LIQ. SINCE PREV RCNST, TOTAL DOSE = 2.03

AT TIME 600.0,  1.00 PERS AT TGT PT 167 (FGHM=  60) IN ORIG MOPP PSTR RCV PRC LIQ. SINCE PREV RCNST, TOTAL DOSE = 1.15

AT TIME 600.0,  1.00 PERS AT TGT PT 170 (FGHM=  77) IN ORIG MOPP PSTR RCV PRC LIQ. SINCE PREV RCNST, TOTAL DOSE = 0.82

AT TIME 600.0,  1.00 PERS AT TGT PT 171 (FGHM=  77) IN ORIG MOPP PSTR RCV PRC LIQ. SINCE PREV RCNST, TOTAL DOSE = 0.82

AT TIME 600.0,  1.00 PERS AT TGT PT 172 (FGHM=  60) IN ORIG MOPP PSTR RCV PRC LIQ. SINCE PREV RCNST, TOTAL DOSE = 0.80

AT TIME 600.0,  1.00 PERS AT TGT PT 173 (FGHM=  62) IN ORIG MOPP PSTR RCV PRC LIQ. SINCE PREV RCNST, TOTAL DOSE = 0.68
```

Example 29. Dosage Table (Chem).

```
DOSAGE TABLE
***************

2.00 PERS., ID #  16 PSTR  =  1  AT ( X , Y ) =  497.   1377. RCVD. NUC. DOSE =   193.15  N/GAMMA =  1.62

1.96 PERS., ID #  19 PSTR  =  1  AT ( X , Y ) = 2202.    326. RCVD. NUC. DOSE =  1236.00  N/GAMMA =  2.81

0.99 PERS., ID #  77 PSTR  =  1  AT ( X , Y ) = 2679.   1657. RCVD. NUC. DOSE =   635.94  N/GAMMA =  2.34

0.99 PERS., ID #  77 PSTR  =  1  AT ( X , Y ) = 2679.   1657. RCVD. NUC. DOSE =   635.94  N/GAMMA =  2.34

1.98 PERS., ID #  24 PSTR  =  1  AT ( X , Y ) = 1509.    160. RCVD. NUC. DOSE =   779.33  N/GAMMA =  2.48

2.00 PERS., ID #  25 PSTR  =  1  AT ( X , Y ) = 1548.     57. RCVD. NUC. DOSE =   417.74  N/GAMMA =  2.07

1.00 PERS., ID #  29 PSTR  =  1  AT ( X , Y ) = 2621.   1774. RCVD. NUC. DOSE =   597.19  N/GAMMA =  2.30

1.00 PERS., ID #  30 PSTR  =  1  AT ( X , Y ) = 2621.   1770. RCVD. NUC. DOSE =   607.12  N/GAMMA =  2.31
```

Example 30. Dosage Table (Nuc).

(original) or ALT (alternate). The dosage type is the next entry in the table and may be either a "PRC LIQ" (percutaneous liquid) or "TOX VPR" (vapor) chemical agent. Finally, the cumulative total dosage received (up to the current time period of interest) by each target point is reported.

The Nuclear Dosage Table (Example 30) first lists the number of personnel within the asset group receiving nuclear dosage. Next, the identification number corresponding to that asset group is given. The asset identification number can be cross-referenced with the Asset Table to determine the name of the asset as well as other information related to the asset. Following this information is the posture and nuclear kill criteria. The nuclear posture is a code number which describes the protective posture of personnel. In AURA, codes No. 1, 2, and 3 are reserved for the postures, "in the OPEN," "in the OPEN-BUT-THERMALLY-SHIELDED," and "in a FOXHOLE," respectively. Codes No. 4–16 may be specified by the user and can be used to indicate such postures as "in a TANK," "in an APC," etc. The nuclear posture code assigned is related to the amount of shielding the user affords personnel within the asset group. In Example 30, all assets listed in the table have nuclear posture 1 (in the OPEN), which means no shielding from the nuclear blast. The deployment coordinates for the affected assets are reported following the posture entry. Next, the nuclear dosage (specified in rads) received at the specified target point is reported. The last entry in the table is the neutron-to-gamma ratio, associated with the shielding input.

2.3.5 DUMP8. Example 31a depicts a sample of the data generated by the inclusion of the DUMP8, ON output option in the AURA input runstream. During the AURA optimization process, the Asset Allocation Algorithm, simulating the commander's resource allocation decisions, reports the status of the allocation process at each reconstitution time designated in the input runstream. Usage of the DUMP8 option provides a consolidated unit status report for each replication and enables the user to track the criteria inherent to the dynamic asset allocation process. These criteria are reported on FORTRAN unit No. 8 in the general format described below in the following text.

Reported first is the output header label. This is the same information as produced at the top of the standard output (FORTRAN unit No. 6) and serves to identify the time and optional comments for the AURA run. Next, the random number seeds inherent to the replication are

DUMP8 OUTPUT

```
ENCOUNTER NUMBER 1

AURA RUN
ASP1B  AMMUNITION SUPPLY POINT IN MOPP 0
RUN ID #    05/ 15/91       09:56:27

************************************

     ((( RANDOM NUMBER SEEDS AT START =  64310.  58218.  16804.  )))

REPLICATION 1      R.N. SEEDS =  64310.  58218.  16804.

TIM =   0.0,  EFF = 1.0000,  SCH =  1,  WKLS = ---
TIM =  15.0,  EFF = 0.2500,  SCH =  1,  WKLS =  -5
TIM =  30.0,  EFF = 0.2500,  SCH =  1,  WKLS =  -5
```

WHERE:

TIM is the time (in minutes) of the reconstitution
EFF is the unit effectiveness value at time TIM.
SCH is the number of the chain that is under consideration
WKLS is the number of the weak link that is limiting effectiveness

(a)

DUMP9 OUTPUT

```
AURA RUN
ASP1B   AMMUNITION SUPPLY POINT
RUN ID #    05/15/91    09:56:51

      1    3    1     0.896E+02  0.121E+04  -0.697E+02  0.697E+02  MLRS

     -1   -1   -1     0.000E+00  0.000E+00  0.000E+00  0.000E+00

     48

      1    1  600.000  2292.168  1619.270  0.000  2505.000  1772.000  0.000

      1    1  600.000  2231.815  1673.686  0.000  2525.000  1772.000  0.000

      1    1  600.000  2310.285  1645.686  0.000  2545.000  1772.000  0.000

      1    1  600.000  2311.853  1620.809  0.000  2565.000  1772.000  0.000

      1    1  600.000  2258.334  1590.789  0.000  2585.000  1772.000  0.000
                                 .
                                 .
                                 .
      1    1  600.000  2456.451  1635.880  0.000  2725.000  1772.000  0.000
```

(b)

Example 31. Dump8 and Dump9 Outputs.

output. Finally, at each reconstitution time, the unit effectiveness, the number of the subchain that is limiting performance, and the weak link within the subchain is reported. In Example 31a, at the time 15.0 min into the mission, the unit was at 25% effectiveness, and subchain No. 1 contained the weak link, which was link No. 5. A minus sign preceding the link number indicates that the link has been limited by the number of assets allowed to perform in the link.

2.3.6 DUMP9. Example 31b shows a sample of the data generated by the DUMP9, ON output option. This data is written to FORTRAN output unit No. 9 and reports the incoming weapon parameters, including weapon identification descriptors (as assigned by AURA), designated aim points, and actual burst points. The amount and type of information written to unit No. 9 is dependent upon the scenario type modeled. Example 31b depicts the information reported for a chemical scenario. The following sections will reference the information provided for a conventional and nuclear scenario.

Reported initially is the output header label. This information serves to identify the time and optional comments for the AURA run. The first line of data in Example 31b depicts a chemical scenario and reports the weapon number, weapon type, lethality code, weapon range parameters, and the weapon name. The weapon number is sequentially assigned by AURA with respect to the order that the weapons were input. A value of 999 as the weapon number indicates a nuclear scenario. The weapon type, shown as 3 in this example, is the code used by AURA to differentiate which scenario is being modeled. In AURA, weapon types are coded 1, 2, and 3 and represent a conventional, nuclear, and chemical scenario, respectively. The lethality code for a chemical scenario translates to the chemical agent modeled. In a chemical scenario, codes 1, 2, 3, and 4 correspond to 'G', 'V', 'H', and 'T' agents, respectively. For a nuclear and conventional scenario, a non-zero lethality code number simply indicates that there is a lethality data file from which to access the necessary lethality data. Next, the Cartesian coordinates representing the range of weapon effects are reported. In a nuclear scenario, these values are immeasurable, and AURA simply reports a meaningless value of 1.0 for all range directions. In a conventional scenario, the maximum X-Y coordinates realized for the weapon effects are reported. In a chemical scenario, as shown in Example 31b, the crosswind and downwind coordinates of the chemical cloud pattern are reported. The final piece of data reported in the first line is the alphanumeric

weapon name. In this case, the Multiple Launch Rocket System (MLRS) is being modeled. The second line of data in Example 31b is used to indicate the end of weapon data and is represented by values of -1 for the weapon data and 0.0 for the coordinates.

The next section of the DUMP9 Table reports the criteria inherent to each individual weapon round in the scenario. This section begins with the value of the total number of rounds in the scenario. In this case, the number of rounds totaled 48 by virtue of the fact that there were 4 MLRS volleys (each volley contains 12 rounds). The remaining data in the unit No. 9 file are the targeting parameters for each round employed in the scenario. Reported for each round are the replication number, weapon number, time of detonation, and the associated burst point and aim point coordinates. In Example 31b, the first round shown occurred at 600.0 min into the first replication from weapon No. 1. The actual burst point for this round were (2,292.17, 1,619.27) with a height of burst of 0.0 m. The designated aim points for this round were (2,505.00, 1,772.00). It should be noted that the X coordinates (of the aim points) for the remaining rounds increase by 20 m/round. This information can be used to verify the targeting methodology used for the scenario.

2.3.7 Asset Restedness. Example 32a illustrates the Asset Restedness Table produced as a result of specifying the output option FATIGUE,ON. This table is printed for each reconstitution and provides the user with a listing of the amount of SLUNITs used, or gained, as well as the current sleep deprivation status for each personnel asset. Recall, a SLUNIT is defined by AURA as 1 minute of effective rest. Therefore, to say that an asset has 480.0 SLUNITs means that the asset has received 8 hours of rest. A detailed description of the AURA sleep deprivation model is the subject of chapter 4.3 of Volume 1 (Sheroke et al. 1990b).

The first line reports the time at which the asset's sleep deprivation is updated and is shown by the header "SLUNIT (RESTEDNESS) UPDATE AT TIME 1440.0." The subsequent lines list, by asset number, the number of SLUNITs gained, used, and the current total for that asset. For instance, in Example 32a, asset No. 16 gained 0.00 SLUNITs and used 220.0 SLUNITs, which implies that this asset was working during the time period of interest. The current total SLUNITs for this asset is 1,300.0. The remainder of the assets shown in Example 32a depict the AURA default of 1,520.00 SLUNITs as the SLUNIT total.

```
ASSET RESTEDNESS
******************

SLUNIT ( RESTEDNESS ) UPDATE AT TIME  1440.00

ASSET   16  GAINED   0.00 AND USED  220.00 SLUNITS.  CURRENT TOTAL = 1300.00
ASSET   17  GAINED   0.00 AND USED    0.00 SLUNITS.  CURRENT TOTAL = 1520.00
ASSET   18  GAINED   0.00 AND USED    0.00 SLUNITS.  CURRENT TOTAL = 1520.00
ASSET   19  GAINED   0.00 AND USED    0.00 SLUNITS.  CURRENT TOTAL = 1520.00
ASSET   20  GAINED   0.00 AND USED    0.00 SLUNITS.  CURRENT TOTAL = 1520.00
ASSET   21  GAINED   0.00 AND USED    0.00 SLUNITS.  CURRENT TOTAL = 1520.00
```

(a)

```
ASSETS RESTING
*****************

ASSETS RESTING DURING THE NEXT TIME INTERVAL:

12.00 MEMBERS OF ASSET GROUP  86 RESTING SINCE TIME  1240.00  CURRENT SLUNITS =  2.50
12.00 MEMBERS OF ASSET GROUP  85 RESTING SINCE TIME  1240.00  CURRENT SLUNITS =  2.50
12.00 MEMBERS OF ASSET GROUP  84 RESTING SINCE TIME  1240.00  CURRENT SLUNITS =  2.50
12.00 MEMBERS OF ASSET GROUP  82 RESTING SINCE TIME  1240.00  CURRENT SLUNITS =  2.50
12.00 MEMBERS OF ASSET GROUP  81 RESTING SINCE TIME  1240.00  CURRENT SLUNITS =  2.50
12.00 MEMBERS OF ASSET GROUP  80 RESTING SINCE TIME  1240.00  CURRENT SLUNITS =  2.50
```

(b)

Example 32. Asset Restedness (a)/Assets Resting (b).

2.3.8 Assets Resting. The Assets Resting Table illustrated in Example 32b, begins with the line, "ASSETS RESTING DURING THE NEXT TIME INTERVAL." This is the second table resulting from the output option FATIGUE,ON. The table lists, for each asset group, the number of members for that asset group that are resting at the given time. Also included is the current or total SLUNITs for each member of the listed group. In the first line of Example 32b it is shown that 12.00 members of the asset group No. 86, have been resting since time 1,240.0 (minutes), and that each of the assets of this group now have a total of 2.5 SLUNITs.

2.3.9 Optimize. Example 33 reports the information printed when the OPTIMIZE, ON option has been specified within the output section of the input runstream. This information provides a complete printout of the "decisions" being made by the AURA commander model (the AURA asset allocation algorithm) in its attempt to maximize unit effectiveness. The AURA asset allocation algorithm (AAAA) models the dynamic process of battlefield decision making by the unit commander in the effort to utilize the best available assets for each mission task with the goal of "optimizing" the unit's ability to perform a specified mission. The means of solution in this process can be viewed in the same manner as any optimal path problem. That is, the AURA commander model will try every possible combination of assets-to-jobs and choose the combination that produces the maximum unit effectiveness value. An important part of the optimization process is the ability to model the phenomena of decision-making utilizing recursive memory storage techniques. The AAAA is capable of modeling the recursive nature inherent to the optimization process. For example, the optimal path decision-making process may lead the commander to assign assets for several levels of unit taskings. The commander must then "remember" the current optimal path while transversing the remaining possibilities. If the optimal path can be further optimized beyond a given level, the commander must "recall" back to the level of similarity and store the updated optimal path. In AURA, the process of transversing backwards in a recursive manner is termed a "walkback." When the OPTIMIZE, ON option is specified, every node in the transversal of the AURA optimization subroutines encountered during the simulation is reported. The AURA optimization subroutines are OPTMIZ, CPLOPT, ORLOPT, SBCOPT, CRWOPT, and LNKOPT and are responsible for the optimization of chains, compound links, orlinks, subchains, crews, and links, respectively. Example 33 illustrates the optimization walkback process.

```
OPTIMIZATION WALKBK AT TIME        0.0
STARTING TO OPTIMIZE CHAIN    1   SEGMENTS IN ORDER FRAGILITY, AND MAX AVL; ASSETS :
     2 (  2.00)    1 (  4.00)    3 (  4.00)    5 (  4.00)    6 (  4.00)    4 (  20.00)    7 ( CPL/ORL)

           WALKBK: [PRE] IN OPTIMIZ. WEAKEST SEG =  4.   EFF = 0.00
WALKBK:      4  0  0  0  0  7. ID,AVL,SBPT,FAT,MOPP,TDG,DS-TM,ELM,ENT,LKEFF= 46 0.50 1.00 1.00 1.00 1.00 1.00 0.50 0.50 0.02  *
           WALKBK: [POST] IN OPTIMIZ. WEAKEST SEG =  4.   EFF = 0.02

           WALKBK: [PRE] IN OPTIMIZ. WEAKEST SEG =      7.   EFF = 0.00
           WALKBK: [PRE] CPLOPT: MOST PROM. PART =  12.   EFF = 0.00
           WALKBK: [PRE] SBCOPT.  WEAKEST SBCHN ELMNT =  1.   EFF = 0.00
WALKBK:      7  12  0  12  0  9. ID,AVL,SBPT,FAT,MOPP,TDG,DS-TM,ELM,ENT,LKEFF=  4 0.50 1.00 1.00 1.00 1.00 1.00 0.50 0.50 0.10
           WALKBK: [POST] SBCOPT.  WEAKEST SBCHN ELMNT =  1.   EFF = 0.10
           WALKBK: [PRE] SBCOPT.  WEAKEST SBCHN ELMNT =  2.   EFF = 0.00
WALKBK:      7  12  0  12  0 10. ID,AVL,SBPT,FAT,MOPP,TDG,DS-TM,ELM,ENT,LKEFF= 85 0.50 1.00 1.00 1.00 1.00 1.00 0.50 0.50 0.02  *
           WALKBK: [POST] SBCOPT.  WEAKEST SBCHN ELMNT =  2.   EFF = 0.02
           WALKBK: [PRE] SBCOPT.  WEAKEST SBCHN ELMNT =  3.   EFF = 0.00
WALKBK:      7  12  0  12  0 11. ID,AVL,SBPT,FAT,MOPP,TDG,DS-TM,ELM,ENT,LKEFF= 86 0.50 1.00 1.00 1.00 1.00 1.00 0.50 0.50 0.05  *
           WALKBK: [POST] SBCOPT.  WEAKEST SBCHN ELMNT =  3.   EFF = 0.05
ATTEMPTING TO LEVEL SUBCHN. IWK,WEAK,EVEN =    10   0.02   0.04
           WALKBK: [PRE] SBCOPT.  WEAKEST SBCHN ELMNT =  2.   EFF = 0.02
WALKBK:      7  12  0  12  0 10. ID,AVL,SBPT,FAT,MOPP,TDG,DS-TM,ELM,ENT,LKEFF= 85 0.50 1.00 1.00 1.00 1.00 1.00 1.00 1.00 0.05  *
           WALKBK: [POST] SBCOPT.  WEAKEST SBCHN ELMNT =  2.   EFF = 0.05
           WALKBK: [POST] CPLOPT.  MOST PROM. PART =  12.   EFF = 0.05
           WALKBK: [POST] IN OPTOMIZ. WEAKEST SEG. =    7.   EFF = 0.02
```

Example 33. Optimize Table.

The walkback process begins upon commencement of the scenario as shown in the first line of Example 33. Reported next is a listing of the chain segment numbers in the order of most fragile (least effective) to the strongest. In AURA, segment fragility is measured by the number of effective assets which can serve in the segment. That is, the lower the number of effective assets available to a segment the more fragile the segment. In Example 33, Chain 1 contains seven segment numbers each followed (in parentheses) by the number of assets required in the segment. Segment No. 7 is shown to have CPL/ORL in lieu of an integer value for the number of assets. In this case, AURA assumes that since segment No. 7 is comprised of either a compound link (CPL) or an orlink (ORL), the fragility of this segment is small and therefore listed last in the segment list. This assumption can seemingly be flawed if the number of assets in the compound link/orlink is less than that of the previously listed segments. However, the thoroughness of the AURA optimization process will alleviate this discrepancy at a later reporting time. The remainder of the optimization walkback report depicts the dynamic process followed by the AURA asset allocation algorithm. For every subroutine encountered in the traversal, the walkback reports the string "WALKBK:" followed by the traversal direction, optimization subroutine name, number of the weakest segment, and the unit effectiveness for the current path. The traversal direction can be viewed in two ways: the direction of the overall path and the subroutine reporting location. From the overall path perspective, the string "PRE" refers to the downward path taken through the optimization subroutines while "POST" refers to an upward path. Additionally, the strings "PRE" and "POST" represent the beginning and ending reporting location within the optimization subroutine. To further explain this subject, the AURA optimization subroutines are structured in a hierarchical method in the same manner as the AURA functional structures. The hierarchy from top to bottom for functional structures (with corresponding subroutines) are as follows: chains (OPTMIZ), compound links (CPLOPT), orlinks (ORLOPT), subchains (SBCOPT), crews (CRWOPT), and links (LNKOPT). Therefore, to say that a traversal is in the downward direction means that the path taken is in the top-to-bottom direction.

AURA's commander model is based upon the premise of optimizing the links (or jobs) in the unit. Subroutine LNKOPT contains the methodology for the assessment, reassignment, and allocation of assets within these links. During the optimization walkback process, each pass through subroutine LNKOPT produces a status report of the link currently being optimized. The information reported includes the following: the numbers of the functional

structures containing the link undergoing optimization, the link identification number, thc number of assets currently assigned in the link, effectiveness of substitute to be used in link, degradation due to fatigue on this link, degradation due to wearing MOPP ensemble, total degradation, effective degradation of available substitute, number of effective assets currently assigned in link, total number of assets assigned to link, and the current link effectiveness. The functional group numbers are reported in sequence, representing the chain segment, the compound link part, the orlink branch, the subchain element, the crew, and the link. In Example 33, the first pass through subroutine LNKOPT produced the line: WALKBK: 4 0 0 0 0 7 ID, AVL, etc. This is interpreted as link No. 7 in chain segment No. 4 is being degraded by asset group No. 46 which contains 0.50 assets. The zeros indicate that link No. 7 is not a part of a higher order structure. Furthermore, the following facts can be derived:

- The substitute available to replace the most degraded asset can perform the job at 100% effectiveness;
- The asset may be degraded by fatigue and MOPP if applicable (a value of "1" indicates the asset will be subjected to 100% of the degradation effects);
- The asset may be degraded a maximum of 100%;
- There are currently 0.50 assets assigned to this link in which a maximum of 0.50 assets required;
- And, the resultant link effectiveness based upon the aforementioned criteria is 2%.

Also provided within the traversal process are informative notations indicating important conclusions drawn from the optimization process. For example, the strings "TRYING SECOND LEVEL SUBSTITUTION" or "FAILED TO IMPROVE LINK" may appear within the traversal indicating the optimization status. It should be noted that all informative messages emanate from the link optimization subroutine LNKOPT, which is the algorithm responsible for all asset reallocation actions. The complete list of possible notations which may appear in the optimization walkback report and their descriptions follow.

EFF. OF LINK JXYZ = ___ IS > GOAL OF ___

- This message which, if spelled out, reads "Effectiveness of link/job at target point (JXYZ) is greater than the goal

effectiveness for this link" and is used to report an improvement for the current link. The goal effectiveness of each link is set to 1% greater than the effectiveness value of the link being optimized. Therefore, this diagnostic simply means that at the current reporting time the commander, via reallocation decisions, improved the effective capability of the link/job at target point (JXYZ) by at least 1%.

INSUF. CAP. : ID, MOPP, DS-TM, FAT, TDG

- "INSUFFICIENT CAPABILITY." This diagnostic indicates that the current asset under consideration is not capable of improving the link. The asset identification number (ID) is reported as well as the degradation criteria (described above) corrupting the asset's capability.

TRYING SECOND LEVEL SUBSTITUTION

- This diagnostic indicates that the "commander" has been forced to try a "second best" substitute for the current link under consideration.

SUCCEEDED: BKFLLED XXX OF ID YYY, REPLACING ID ZZZ IN LINK XYZ

- The "commander" has successfully improved the effectiveness of the current link under consideration. Read as "backfilled the number of available assets (XXX) of asset group ID (YYY), replacing asset ID number (ZZZ) in link number (XYZ)." This means that the commander was able to improve the effective link capability by substituting asset (ZZZ) as a replacement for asset (YYY) in link XYZ.

INSUFFICIENT PROGRESS IN OPTIMIZING LINK ___, DETECTED IN LNKOPT

- The effectiveness of the current link under consideration has yet to be improved (at this reporting time).

* FAILED TO IMPROVE *
(ANY ASSIGNMENTS INTO THIS LNK/CRW/SBC NOT MADE)

- "Commander" cannot improve the effective capability of the current link, crew, or subchain under consideration.

** WARNING-22 ** AT LEAST ONE LINK OPTIMIZATION TERMINATED BECAUSE ADDITION OF (POSSIBLY DEGRADED) ASSETS RESULTED IN INSUFFICIENT IMPROVEMENT. DETAILS WRITTEN ON FILE 8 IF DUMP8 OPTION IS ON.

- Self explanatory. See DUMP8 file description.

2.3.10 Particular Assets. The PARTICULAR ASSETS option serves as an output control tool by allowing the user to restrict the assets to be included in casualty reports, dosages, contamination reports, etc. For instance, if PARTICULAR ASSETS, CRANE OPER, SERVC PERS is specified in the input runstream, this would restrict all entries, in outputs listed previously, to include only the assets, CRANE OPER and SERV PERS.

2.3.11 Posture. Example 34 reports the battlefield posture of unit personnel. This table is useful to the analyst in determining which assets have undergone a change in protective posture and the time that the posture change occurred. This table is generated only when the output option POSTURE,ON is specified in the input runstream.

There are four types of posture changes which can be reported in this table. For this example, a change to "INVULN. MOPP" was resultant of the scenario modeled and caused asset No. 46 to change from its original MOPP to MOPP4 at time 1,080.0 minutes. In AURA, MOPP4 is considered to be the default invulnerable MOPP. The other possible posture for

```
POSTURE TABLE
****************

AT TIME  10880.0, TGT PT   1 ( ASSET ID =   46 ) WENT TO INVULN. MOPP PSTR.

AT TIME  10880.0, TGT PT   2 ( ASSET ID =   60 ) WENT TO INVULN. MOPP PSTR.

AT TIME  10880.0, TGT PT   3 ( ASSET ID =   35 ) WENT TO INVULN. MOPP PSTR.

AT TIME  10880.0, TGT PT   4 ( ASSET ID =   81 ) WENT TO INVULN. MOPP PSTR.

AT TIME  10880.0, TGT PT   5 ( ASSET ID =  81 ) WENT TO INVULN. MOPP PSTR.

AT TIME  10880.0, TGT PT   6 ( ASSET ID =  25 ) WENT TO INVULN. MOPP PSTR.

AT TIME 10880.0, TGT PT   7 ( ASSET ID =  14 ) WENT TO INVULN. MOPP PSTR.

AT TIME 10880.0, TGT PT   8 ( ASSET ID =  88 ) WENT TO INVULN. MOPP PSTR.
```

Example 34. Posture Table.

this chemical scenario example would be "ALT. MOPP," which means that the asset changed to a predefined MOPP different from the one initially assigned. The DEPLOYMENT and REST input commands described in the AURA Input Manual (Klopcic, Sheroke, and Price 1990) are examples of two possible methods by which to specify an alternate MOPP. When modeling a conventional or a nuclear scenario, there are two types of protective postures that will be output in this table. These postures, defined in the same manner as those typical of a chemical scenario, are as follows: "WENT TO ALT. CONV/NUC" and "WENT TO INVULN. CONV/NUC."

2.3.12 Random Number Seeds. Example 35 illustrates the output of the random number seed values used at the beginning of and throughout the AURA execution. The primary usage of the RANDOM NUMBER,ON output option is to provide the capability to report the random numbers drawn and used for each replication. Random numbers are used frequently within AURA to statistically sensitize data such as weapon delivery errors, personnel vulnerability to nuclear/chemical dosages, and general statistical methods inherent to simulation modeling. AURA contains a default set of random number seeds which are used to initiate the random number generation process. (See subroutine DEFALT in Volume 2 for AURA defaults) (Sheroke et al. 1990a). The SEED input command permits the user to define a customized set of random number seeds to be used for the following phenomena modeled in AURA: WEAPON, FAILURE, and HEAT STRESS. The methodology of these phenomena is described in Volume 1 of the AURA Programmer/Analyst Guide, and the SEED command is described in the AURA Input Manual (Sheroke et al. 1990b; Klopcic, Sheroke, and Price 1990).

2.3.13 Reconstitution. The RECONSTITUTION output command causes an asset status report after every reconstitution event. The parameters available with the RECONSTITUTION command are PARTIAL, ON, and ONCE and are described below. The RECONSTITUTION command also provides the capability to restrict the reconstitution results produced to a specific time interval within the simulation. The AURA Input Manual (Klopcic, Sheroke, and Price 1990) provides the spectrum of options and parameters for use with the RECONSTITUTION command.

RANDOM NUMBER SEEDS

(((RANDOM NUMBER SEEDS AT START = 63410.   58218.   16804.   93359.   7398.)))
.
.
.
.
(((RANDOM NUMBER SEEDS AT END = 86134137.   1661488710.   16804.   93359.   7398.)))

Example 35. Random Number Seeds.

Usage of the RECONSTITUTION, PARTIAL output option results in the table shown in Example 36. The information reported in this table is described for every reconstitution time and includes the current status of such data as the following: equipment contamination, unit effectiveness, jobs/links engaged in mission, and the analysis of the links which may be degrading the unit.

Reconstitution number 2, shown second in Example 36, provides the entire spectrum of information produced by the RECONSTITUTION, PARTIAL command. The first datum reported is the time of the reconstitution event. In this case, the unit reconstituted at a time of 10,995.0 min into the scenario. Next, the contaminated equipment status is reported. The modeling of contaminated equipment is optional in AURA and can be controlled via the CONTAMINATED USAGE command in the input runstream. The CONTAMINATED USAGE command allows the user to specify the assets (equipment) which may still be used for the mission even though they are contaminated as a result of a chemical attack. This table reports the asset identification number(s) of any assets which have been designated as contaminated usable. If no assets have been designed contaminated usable, the word "NONE" is reported as shown in Example 36. Reported next is the number of the operant chain, its effectiveness, and, if applicable, the weakest (most degraded) segment of the chain. In this example, at time 10,995.0 min, chain number 1 is operating at 25% and is being most degraded by the third chain segment. The complete list of link numbers used in the mission is shown next. This information serves primarily as a reference tool to verify which links are being used at this time period.

The final section of data presented is the weak links analysis. The identification number of the job which is most degrading (i.e., the weak link) and the reason for degradation are printed here. The effectiveness value of this weak link is reported as well as the effectiveness of the mission segment impacted by the weak link. The reason for degradation is explicitly shown in this example as being "LINK 5 HAS NO ITEMS ALLOCATED." One can then conclude that the assets required to perform link number 5 have either become casualties or are being used as replacements in other jobs more critical to mission accomplishment. In this case, link number 5 degraded the unit the most with an effectiveness value of 0%. The impact of the lack of effectiveness in job number 5 resulted in an effectiveness value of 15% for the tasking represented by segment number 3.

```
RECONSTITUTION  (PARTIAL)
*****************************

RECONSTITUTION NUMBER 1 AT TIME          0.0

CONTAMINATED EQUIP. BEING USED. ID # =  NONE

<<<RECONSTITUTION 1, TIME  0.0       CHAIN  1 .EFF = 1.00          WEAKEST SEGMENT IS #    0

***LINKS USED IN FULL CHAIN: 3  4  5  6  7  8  12  13  24  14  25  15  26  16  27  17  28  29  19
                                   30 20 31 21 32 22 33 23 34 9 10 11


#  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #


RECONSTITUTION NUMBER 2 AT ITME  10995.0

%%TIMER%%  FINISHED REPLIC.  1.  CPUTIM=  5.351    TOP OF MEMORY  (ITOP)  = 61058

CONTIMINATED EQUIP.  BEING USED ID # =  NONE

<<<RECONSTITUTION  2, TIME  10995.0  CHAIN   1. EFF = 0.25         WEAKEST SEGMENT IS #    3

***LINKS USED IN FULL CHAIN: 3  4  5  6  7  8  12  13  24  14  25  15  26  16  27  17  28  29  19
                                   30 20 31 21 32 22 33 23 34 9 10 11


***WEAK LINKS ANALYSIS ***
LINK 5 HAS NO ITEMS ALLOCATED
MINUS SIGN INDICATES LINK LIMITED BY MAXIMUM ALLOWED IN LINK,  RATHER THAN ASSET NON-AVAILABILITY
***         WEAK LINK:  -5
***    EFFECTIVENESS:  0.00
***    ASSET QUALITY:  0.00
*  JOB DEGRADATION:  0.15

#  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #  #
```

Example 36. Reconstitution Table.

If the RECONSTITUTION, ON option is specified, the results produced by the RECONSTITUTION, PARTIAL (described above) are reported in conjunction with a complete matrix of the current assignments of assets to links. Example 13 depicts an example of this matrix, known as the Link-Substitutability matrix. Recall, from the Link Status Table (Example 13), for each asset type, the links (or jobs) in which the members of the asset type can serve are shown. The letter "H" signifies the asset deployed is a "homelink." A homelink is the primary job of the asset in which it can immediately serve with 100% effectiveness. An entry of the form time/effectiveness/order indicates a job into which an asset can substitute in the time amount (minutes) and with the corresponding effectiveness value. The order number indicates the sequence in which the user specified the substitutes and is used to choose one particular substitute over another if all other quantities (namely, versatility and effectiveness) are equal. Finally, a blank entry indicates that no substitution is possible for the link.

If the RECONSTITUTION, ONCE option has been designated, all information output by the RECONSTITUTION, ON command will be reported for the initial reconstitution only.

2.3.14 Table of Surviving Assets. Example 37 depicts the Table of Surviving Assets, which reports the surviving assets at each reconstitution time. This table is generated at the end of every replication when the output option "REPLICATION, ON" is specified in the input runstream. This table is generally used as a tool to determine the specific assets which were attrited in each replication. The format of the Table of Surviving Assets is described in the following paragraphs.

Prior to reporting the surviving asset data, the number of the current replication is printed. The column headers for each individual asset name, with its corresponding identification number, are printed below the table header. In this example, only the surviving assets within the first 25 asset types are shown. The column header "TIME" represents the user-specified internal reconstitution times of interest. In Example 37, 0.0, 15.0, and 30.0 have been specified as reconstitution times for the unit under study. The initial time reported refers to the commencement of the simulation and generally corresponds to the time of attack. The time of attack used in this example is 0.0 min. The number of survivors reported for each asset group at time 0.0 min into the simulation is equivalent to the initial available assets for each asset group. The Table of Surviving Assets reports the status of every asset available

REPLICATION NUMBER 1
****

TABLE OF SURVIVING ASSETS
****

TIME	FIREME N 1	FIRETE AM 2	RECORD S 3	CRANE 4	FRKLFT 6A 5	FRKLFT 6B 6	FRKLFT 6C 7	FRKLFT 6D 8	FRKLFT 6E 9	FRKLFT 6F 10	FRKLFT 6G 11	FRKLFT 6J 12	FRKLFT 4K 13	FRKLFT 4L 14	FRKLFT 4M 15	USERS A 16	USERS B 17
0.00	0.00	0.0	4.00	6.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00
15.00	0.00	0.0	4.00	5.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00
30.00	0.00	0.0	4.00	5.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00

TIME	USERS C 18	USERS D 19	USERS E 20	USERS F 21	USERS G 22	USERS K 23	USERS L 24	USERS M 25
0.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
15.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
30.00	2.00	2.00	4.00	2.00	2.00	2.00	2.00	2.00

.
.
.

%% TIMER %% FINISHED REPLIC. 1. CPUTIM = 5.381. TOP OF MEMORY (ITOP) = 61058

Example 37. Table of Surviving Assets.

to the unit. When the number of surviving assets is initially equal to 0.0, this corresponds to a DUMMYLINK. Recall, a dummylink is defined as a job which has no asset of the same name. DUMMYLINKS are links which have no particular assets assigned to them but are filled, when needed, by substitutes. For further information on DUMMYLINKS, the analyst is referred to the AURA Input Manual (Klopcic, Sheroke, and Price 1990). For this reason, the number of survivors will remain 0.0 unless the job is performed. In this example, the first two assets listed in the table, "FIREMEN" and "FIRETEAM," are dummylinks and have 0.00 listed as the number of survivors.

Finally, the replication table reports the amount of computer CPU time required for the replication. This information can be used by the programmer/analyst to trace the computer time requirements of each replication.

2.3.15 Timer Output Table. The data reported in Example 38 represent the computer time at specified times of interest during the simulation. The primary use of these data is to provide the AURA programmer/analyst with a method to diagnose larger than expected time requirements during the simulation. The TIMER,ON option causes the Timer Output Table to report the computer time at the beginning and end of each of the AURA events. This allows the user a means to measure the computer time required by portions of an AURA execution.

The Timer Output Table consists of outputs in the form "%%TIMER%% BEGINNING EVENT 1. CPUTIM= 4.634." This simply states that the first event began at the time 4.634 seconds into the AURA execution. The successive time reports indicate the amount of time before the next event begins. With this information, the user can subtract from the previous time to determine the time it took to complete the previous event. This is useful to detect problem areas that may occur during the AURA run. Frequently, this information is used to see which replication took the most time to complete or where the code halted the execution process.

2.3.16 Weapon Table. The Weapon Table reports the targeting parameters associated with each round employed for all replications. This table is commonly used by the analyst to determine the actual ground zero coordinates of the weapon round with respect to the designated aim points. The information in this table can assist the analyst with the

TIMER OUTPUT

```
%%TIMER%% BEGINNING EVENT  1.  CPUTIM=   4.634
%%TIMEk%% BEGINNING EVENT  2.  CPUTIM=   4.691
%%TIMER%% BEGINNING EVENT  3.  CPUTIM=   4.731
%%TIMER%% BEGINNING EVENT  4.  CPUTIM=   4.760
%%TIMER%% BEGINNING EVENT  5.  CPUTIM=   4.788
%%TIMER%% BEGINNING EVENT  6.  CPUTIM=   4.818
%%TIMER%% BEGINNING EVENT  7.  CPUTIM=   5.109
```

Example 38. Timer Output Table.

interpretation of the level of damage incurred by the unit. Note that a large target or delivery error may also contribute to an unexpected low level of damage in a given replication. For example, the analyst may intuitively correlate a high/low degree of precision in weapon accuracy due to an increased/decreased amount of casualties and damage. The analyst will quite often utilize this rationale to explain changes in unit casualties in the study. A typical Weapon Table is illustrated in Example 39.

The first line of the Weapon Table contains the time period of this weapon report as well as the status of target acquisition. In this example, the weapon table reports "AT TIME 0., TARGET ACQUISITION SUCCEEDED," which means that the target was successfully acquired at the start of the simulation. The next line provides the initial target location error (TLE) and the actual target location error calculated by AURA. This information is given in the statement "INITIAL TLE(RANGE,DEFL) = 510.0, 30.0 ACTUAL TLE = (316.0, 30.0)." The actual TLE is calculated by normalizing the initial TLE by a random number multiplier. Only in the case where the initial TLE is (60.0, -60.0) will the initial TLE and actual TLE be the same.

The remainder of the Weapon Table reports the weapon arrival parameters including the following: weapon type, time of detonation, intended aim point, and actual burst point. The string "EMPL# (VOLL#) 1 (1)," represents the weapon employment number (EMPL#) and the volley number (VOLL#). These two values will be the same when the VOLLEY command is used alone. If the ROUND command is used, no volley number will be printed. The weapon number is reported as the next string. In AURA, weapons are sequentially numbered in the order in which they are specified in the input runstream. In this example, weapon No. 1 detonated at time 10,980.0. The statement "DGZ = (2505.0, 1772.0, 0.0)" represents the intended aim point coordinates in the three-dimensional Cartesian system. The final part of the line is "AGZ = (2292.2, 1619.2, 0.0)" which represents the actual ground-zero (AGZ) or actual burst point. The offset realized in the actual ground-zero coordinates (with respect to the intended aim point) is a result of the effect of target location and delivery errors.

```
WEAPON TABLE
****************

AT TIME 0., TARGET ACQUISITION SUCCEEDED
   INITIAL TLE ( RANGE, DEFL ) =    510.0  30.0    ACTUAL TLE = ( 316.0 ,   30.0 )

EMPL#  ( VOLL# )   1  (  1.)  WPN #  1, TIME = 10980.0.  DGZ = ( 2505.0 ,  1772.0 ,  0.0 )  AGZ = ( 2292.2,  1619.3,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2525.0,   1772.0 ,  0.0 )  AGZ = ( 2231.8,  1673.9,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2545.0,   1772.0 ,  0.0 )  AGZ = ( 2310.3,  1645.7,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2565.0,   1772.0 ,  0.0 )  AGZ = ( 2311.9,  1620.8,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2585.0,   1772.0 ,  0.0 )  AGZ = ( 2258.3,  1590.8,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2605.0,   1772.0 ,  0.0 )  AGZ = ( 2613.9,  1644.9,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2625.0,   1772.0 ,  0.0 )  AGZ = ( 2408.4,  1644.4,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2645.0,   1772.0 ,  0.0 )  AGZ = ( 2543.0,  1539.1,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2665.0,   1772.0 ,  0.0 )  AGZ = ( 2350.8,  1613.1,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2685.0,   1772.0 ,  0.0 )  AGZ = ( 2515.2,  1542.9,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2705.0,   1772.0 ,  0.0 )  AGZ = ( 2536.1,  1598.5,  0.0)
EMPL#  ( VOLL# )   1  (  1 )  WPN #  1, TIME = 10980.0   DGZ = ( 2725.0,   1772.0 ,  0.0 )  AGZ = ( 2527.4,  1588.4,  0.0)
      .
      .
      .
EMPL#  ( VOLL# )   4  (  4 )  WPN #  1, TIME = 10980.0   DGZ = ( 2685.0,   1772.0 ,  0.0 )  AGZ = ( 2616.1,  1790.9,  0.0)
EMPL#  ( VOLL# )   4  (  4 )  WPN #  1, TIME = 10980.0   DGZ = ( 2705.0,   1772.0 ,  0.0 )  AGZ = ( 2665.4,  1742.9,  0.0)
EMPL#  ( VOLL# )   4  (  4 )  WPN #  1, TIME = 10980.0   DGZ = ( 2725.0,   1772.0 ,  0.0 )  AGZ = ( 2626.6,  1827.6,  0.0)
```

Example 39. Weapon Table.

2.4 Final - Averaged Results.

2.4.1 Repeat of Warnings. This section provides a consolidated list of the informative warnings which occurred in the AURA run. The warning diagnostics produced by AURA are informative messages indicating a logical disagreement or syntactical error in AURA and do not affect the successful completion of the AURA run. The appendix provides a numerical listing of all AURA warning diagnostics including the recommended solution to resolve cause of warning, reference to appropriate command format in input manual, and the subroutine name from which the warning diagnostic originated.

2.4.2 Effectiveness vs. Time Table. Example 40 depicts the AURA Effectiveness vs. Time Table. This table reports the unit effectiveness status at every reconstitution time during the simulation and includes a frequency distribution of effectiveness values over all replications. For each reconstitution time, the following information is reported: the time (in minutes) of the reconstitution event, the average unit effectiveness value over all replications, the operant chain number, and the frequency distribution of the unit effectiveness value. For example, at the time of 5 min into this simulation, the effective capability of this unit to perform the mission (designated by operant chain No. 1) is 58%. At the next reporting time, 120.0 min, the unit is shown to have improved to a rate of 90%, a rate at which the unit continues to operate for the remainder of the simulation. Generally, the unit is shown to be most degraded during (or shortly after) an attack, as is the case with Example 40 at the 5.0 min point. At the reporting times shown after the attack, the effectiveness of the unit recovers to 90% due to the commander's reallocation of available surviving assets.

2.4.3 Table of Surviving Assets. The Table of Surviving Assets reports the number of surviving assets in each asset group at each reconstitution time. (The user is referred to Example 37 for the illustration of this table.) Included in the survivor totals are those assets which have been contaminated by a chemical or nuclear dose. The data shown in this table provide the AURA analyst with a dynamic view of the status of each asset group throughout the scenario. Each column of the Table of Surviving Assets describes a unique asset group.

EFFECTIVENESS VS. TIME
****

FREQUENCY DISTRIBUTION OF RESULTS
****

TIME	EFFECTIVENESS	OPR	CHNS		100	90-99	80-89	70-79	60-69	50-59	40-49	30-39	20-29	10-19	1-9	0
0.0	1.00	1			100	0	0	0	0	0	0	0	0	0	0	0
5.0	0.58	1			0	0	0	0	1	91	8	0	0	0	0	0
120.0	0.90	1			0	100	0	0	0	0	0	0	0	0	0	0
240.0	0.90	1			0	100	0	0	0	0	0	0	0	0	0	0
360.0	0.90	1			0	1	99	0	0	0	0	0	0	0	0	0
480.0	0.90	1			0	100	0	0	0	0	0	0	0	0	0	0
600.0	0.90	1			0	100	0	0	0	0	0	0	0	0	0	0
725.0	0.90	1			0	100	0	0	0	0	0	0	0	0	0	0

Example 40. Effectiveness vs. Time Table.

The column header lists the asset name and group identification number. The number of surviving assets within each asset group is reported with respect to each reconstitution time. All reconstitution times considered in the modeling scenario are listed in the first column of the table. This table is also described in the intermediate results section of this report.

2.4.4 Cumulative Summary of Heat Stress Casualties. The Cumulative Summary of Heat Stress Casualties Table (illustrated in Example 41) is produced when the individual task input, HEAT STRESS, is included in the input runstream. The table lists the cumulative number of heat stress casualties at the specified internal reconstitution times. For further information on heat stress, the user is referred to the AURA input manual (Klopcic, Sheroke, and Price 1990).

2.4.5 *Survivor Summary Table.* Example 42 illustrates the Survivor Summary Table. This table reports the total number of surviving assets (personnel and equipment) available to the unit at each reconstitution time. The Survivor Summary Table provides an at-end summation of the unit survivors vs. time. Unit survivors are computed as an average over all replications. Also reported is two times the standard deviation of the averaged unit survivors at each reconstitution time. This table is generated only when the SUMMARY (or NUCLEAR SUMMARY) output command has been specified in the input runstream (see the AURA Input Manual [Klopcic, Sheroke, and Price 1990]). The most common usage of the SUMMARY command is in conjunction with the parameter, PERSONNEL, which is depicted in Example 42. Shown in this example, at a time of 8 hr (480.0 min), there was an average of 233.06 (of the original 237.0 deployed) survivors available to the unit. The value of 4.9 is computed as two times the standard deviation realized at the 8-hr reporting time.

2.4.6 Toxic Dose Table. The Toxic Dose Table, illustrated in Example 43, is produced for chemical scenarios only. The table reports, by asset group number, the total assets contained in each dose bin. In addition, a total across all asset groups is reported for each bin. This table is useful for monitoring the percent of unit personnel which may be degraded due to sublethal doses.

The table header is set up so that the numbers in the first row indicate the endpoints of the range for each dose bin. The second row of numbers lists the midpoint value for each range. Column one of the table reports the asset group identification number. Columns two

CUMULATIVE SUMMARY OF HEAT STRESS CASUALTIES
****

TIME	HEAT STRESS CASUALTIES (CUM)
0.0	0.00
5.0	12.95
120.0	24.56
240.0	35.33
360.0	43.54
480.0	48.64
600.0	51.49
725.0	54.12
840.0	55.94
960.0	56.86
1005.0	57.46
1120.0	57.88
1240.0	57.88
1360.0	57.88
1480.0	57.88
1600.0	57.88
1725.0	57.89

Example 41. <u>Cumulative Summary of Heat Stress Casualties</u>.

SURVIVOR SUMMARY, SELECTED CATEGORIES, WITH S. D.
INCLUDES SICK BUT FUNCTIONAL PERSONNEL
DOES NOT INCLUDE CONTAMINATED OR DAMAGED EQUIPMENT
****

TIME	. PERSONNEL .
0.0	237.00 +/- 0.00
480.0	233.06 +/- 4.90
710.0	233.06 +/- 4.90

NOTE: +/- IS 2 TIMES THE STANDARD DEVIATION OF THE MEAN

Example 42. Survivor Summary Table.

TOXIC DOSE
****

*** IV DOSE, NORMALIZED TO 1 LETHAL DOSE ***

ID	NEGLIG	0.05 V 0.10	0.15 V 0.20	0.25 V 0.30	0.35 V 0.40	0.45 V 0.50	0.55 V 0.60	0.65 V 0.70	0.75 V 0.80	0.85 V 0.93	1.00 V 5.50	OVER 10.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.89	0.00	0.00	0.11	0.12	0.14	0.41	0.48	0.32	0.49	0.83	0.00
4	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	1.14	0.00	0.00	0.02	0.09	0.14	0.23	0.24	0.27	0.22	0.24	0.00
11	0.13	0.00	0.01	0.00	0.00	0.00	0.03	0.00	0.05	0.04	0.04	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.01	0.00	0.00	0.00	0.00	0.08	0.18	0.28	0.09	0.31	0.08	0.00
TOTAL	5.12	0.00	0.01	0.13	0.21	0.36	0.85	1.00	0.73	1.06	1.19	0.00

****

Example 43. <u>Toxic Dose Table</u>.

through th·· .ɜen report the number of assets contained in each dose bin. The second column lists the number of assets receiving negligible (NEGLIG) doses. A negligible dose is any dose that is less than 0.05 of the normalized dose. The next column, headed by "0.10," contains assets that have received doses ≥ 0.05 and < 0.15 normalized doses. Note that "0.10" is the midpoint of the range for this dose bin. The remainder of the columns are set up in this manner with the last column containing the number of assets that have received doses ≥ 10.00 normalized doses. In Example 43, under the column headed by "0.5," it is shown that 0.14 assets from group 3, 0.14 assets from group 10, and 0.08 assets from group 14 received doses in the range of ≥ 45% (0.45) to < 55% (0.55) of one lethal dose. In the last line of the table, the total personnel for all asset groups in the bin with the midpoint of 0.5 (normalized doses) is 0.36, which is simply the sum of the previously listed values.

The midpoint values listed in Example 43 are AURA default values. These values may be changed under the mnemonic DOSE PARAMETERS in the input runstream. For more information, the analyst is referred to the AURA input manual (Klopcic, Sheroke, and Price 1990).

2.4.7 Nuclear Dose and Casualties Table. The Nuclear Dose and Casualties Table, illustrated in Example 44, is similar to the Toxic Dose Table (Example 43). It reports for each asset group number, the total number of assets receiving nuclear dosages. In addition, the Nuclear Dose and Casualties Table also reports the totals for immediate, dose-time, blast, and thermal casualties for each asset group.

The dosage portion of the table is set up in the same manner as the Toxic Dose Table with the first row of the header containing the endpoints of the range for each dosage bin and the second row containing the midpoint of each range. The values in the header of the nuclear dose table refer to the number of rads (cGy) received by the asset. The midpoint values listed in the header of Example 44 are AURA default values. These values can also be changed under the DOSE PARAMETERS mnemonic. (See the AURA input manual [Klopcic, Sheroke, and Price 1990].)

NUCLEAR DOSE AND CASUALTIES

****

ID	NEGLIG	5. V 40.	75. V 112.	150. V 225.	300. V 375.	450. V 490.	530. V 680.	830. V 965.	1100. V 1300.	1500. V 3000.	4500. V 6250.	OVER 8000	V TOTAL NUCLEAR CASUALTIES V DOSE-TIME	BLAST	THERMAL
16	0.00	0.20	0.68	0.40	0.48	0.04	0.12	0.08	0.00	0.00	0.00	0.00	0.02	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.10	0.05	0.17	1.66
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09	0.03	0.01	1.88
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.70	0.53	0.75	0.00	0.51
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.94	0.06
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	1.03
23	0.00	0.00	0.00	0.16	0.16	0.12	0.40	0.12	0.28	0.67	0.07	0.00	0.42	0.00	0.02
24	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.68	0.92	0.00	0.00	0.32	0.00	0.00
25	0.00	0.00	0.00	0.00	0.08	0.12	0.64	0.76	0.32	0.08	0.00	0.00	0.14	0.00	0.00
TOTAL	0.00	0.20	0.68	0.56	0.72	0.28	1.36	1.16	1.28	1.94	0.87	0.72	1.73	5.09	5.16

Example 44. Nuclear Dose and Casualties Table.

The casualty portion of the Nuclear Dose and Casualties Table lists, for each asset group, the total number of casualties for each of the following casualty types: immediate, dose-time, blast, and thermal. An immediate casualty results when a personnel asset receives over 8,000 rads. This value is an AURA default but may be changed under the MAX DOSE mnemonic. A dose-time casualty occurs when an individual receives sufficient nuclear dosage over time to kill that asset. Blast and/or thermal casualties are a result of an asset receiving sufficient blast and thermal effects to produce a lethality. The effect of blast is measured in psi^2/sec, while thermal effects are measured in cal/cm^2. The probability of kill (PK) for blast and thermal is calculated in the subroutine, NUCDMG. (For more information, see Volume 1 of the AURA Programmer/Analyst Guide [Sheroke et al. 1990b].) A more detailed report of nuclear casualties can be generated by the use of the CASUALTIES,ON output option (see Casualties, Intermediate Results section.)

As in the case of the Toxic Dose Table, the Nuclear Dose and Casualties Table summarizes the cumulative totals for each dose bin and casualty type.

2.4.8 Thermal and Blast Degradation Status Table. Thermal Degradation Status and *Blast Degradation Status are two tables* produced when the NUCLEAR SUMMARY,ON option is specified within the input runstream. These tables are illustrated in Examples 45a and 45b, respectively.

The Thermal Degradation Status Table lists, for each posture, the total number of personnel assets receiving various levels of thermal fluence. The amount of thermal fluence is divided into ranges as listed in the header of Example 45a. The first column lists the nuclear posture code. Codes 1–3 are reserved for in-the-OPEN, in-the-OPEN-BUT-THERMALLY-SHIELDED and in-a-FOXHOLE, respectively. The remaining postures are user-specifiable postures. The headers for columns two through eight list the various ranges of thermal fluence for the nuclear weapon. Column two lists the number of assets receiving less than 9.3 cal/cm^2. The third column lists the number of assets receiving thermal fluence in the range of 9.3 to 12.5 cal/cm^2, etc. The last column reports the total number of assets receiving amounts of thermal fluence greater than 60.5 cal/cm^2. As an example of how to read this table, the total number of assets in posture 1 (in the open) receiving thermal fluence in the range of 12.6 to 18.9 cal/cm^2 is 159.00. Note that thermal environment is only considered for

THERMAL DEGRADATION STATUS
********** *************** ********

NUKE POSTURE	THERMAL <CAL PER CM**2>						
	< 9.3	9.3 - 12.5	12.6 - 18.9	19.0 - 19.9	20.0 - 38.9	39.0 - 60.5	> 60.5
1	139.68	62.96	159.00	16.16	79.54	6.14	20.54
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(a)

BLAST DEGRADATION STATUS
****** ************** ********

NUKE POSTURE	BLAST < PSI >						
	5.0 - 9.6	9.6 - 19.5	19.6 - 33.5	33.6 - 51.5	51.6 - 74.5	74.6 - 99.0	> 100
1	456.26	10.30	4.92	4.40	2.26	1.70	4.18
2	0.00	0.00	1.97	0.00	0.00	0.00	0.00
3	5.02	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(b)

Example 45. Thermal and Blast Degradation Status Tables.

personnel in posture 1 (in the OPEN). For this reason, values for all other postures in the table will always be 0.00.

The Blast Degradation Status Table is similar to the Thermal Table, except that the bins contain the number of personnel exposed to various levels of blast static overpressure, reported in psi (or lbs/in^2). (For more information, the user is referred to the AURA NUKESDO report [Price 1991].) The nuclear postures are the same for this table as for the thermal table. The first bin reports the number of personnel exposed to 5.0 to 9.6 psi. Blast effects less than 5.0 psi are not reported because these values are considered to be negligible. The highest bin reported is for overpressure values greater than 100 psi. In Example 45b, 2.26 people in posture 1 received between 51.6 and 74.5 psi.

2.4.9 ETI Summary. This table reports the total number of man-weighted early transient incapacitation (ETI) episodes that occur during the simulation. The term "man-weighted" refers to the number of personnel (including fractional persons) undergoing an ETI episode at each reconstitution time, summed over all reconstitution times and averaged over all replications. (A person can have more than one ETI episode during an AURA run.) Output for this table is illustrated in Example 46.

2.4.10 Dose-Degraded Capability and Incapacitation - All Personnel. The Dose-Degraded Capability and Incapacitation - All Personnel Table, illustrated in Example 47, reports the percentage of personnel assets in each effectiveness category and the average effectiveness for all personnel at each internal reconstitution time. The categories are specified as ranges of effective capability values. For example, an asset who is operating at 67% effectiveness at a time of 2 hr (120.0 min) into the mission would fall into the 60–70 percentile range.

The Dose-Degraded Capability and Incapacitation - All Personnel Table produced by a chemical run lists only the percentage of personnel contained in each effectiveness category and the average effectiveness for the unit. For a nuclear scenario, this table also includes entries listing the number of assets experiencing ETI and permanent complete incapacitation (PCI) episodes for each replication. These entries appear as the two right-most columns in the table following the average effectiveness data. Example 47 illustrates this difference between the two scenarios.

ETI SUMMARY: NO. OF (MAN - WEIGHTED) EPISODES = 42.95
****

Example 46. ETI Summary.

These entries are only included in the table for a nuclear scenario.

DOSE - DEGRADED CAPABILITY AND INCAPACITATION - ALL PERSONNEL
****

TIME	1 - 9	10 -19	20 - 29	30 - 39	40 - 49	50 - 59	60 - 69	70 - 79	80 - 89	90 - 99	100	AVE EFFECT.	ETIS	PCIS
0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00
15.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00
30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00
75.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00
105.0	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.06	0.03	0.87	0.97	23.08	0.76
120.0	0.00	0.00	0.01	0.04	0.10	0.04	0.01	0.03	0.14	0.05	0.58	0.85	18.23	1.66
1455.0	0.04	0.11	0.04	0.07	0.06	0.09	0.05	0.03	0.04	0.10	0.69	0.69	0.87	38.71

Example 47. Dose-Degraded Capability (Chem and Nuc).

2.4.11 Contaminated Asset Survivors Table. Example 48 depicts the Contaminated Asset Survivors Table. This table reports the number of contaminated assets in each asset group averaged over all replications. In AURA, an asset may become contaminated if exposed to a chemical agent or nuclear warhead. The user is referred to Volume 1 of the AURA Programmer/Analyst Guide for a detailed discussion of the modeling of contaminated assets in AURA (Sheroke et al. 1990b). The number of contaminated assets in each asset group is reported at each reconstitution time. As shown in Example 48, at 8 hr (480.0 min) into the simulation, 2.00 FRKLFT6C (asset identification No. 7) became contaminated. Note, personnel assets are not considered contaminated; therefore, the number of contaminated personnel will always be zero. For personnel casualty estimates, see Section 2.3.2 of this report.

2.4.12 Link Results vs. Time Table. The Link Results Table, shown in Example 49, reports the final status of all links at each reconstitution time. For each link, the following information is provided: the number of times the link was employed in the mission, the number of times the link was weak due to asset unavailability, the number of times the link was weak due to the limitation of the assets permitted to serve in the link, the number of times the link was used in a compound link, the number of times the link was used in an as-available repair status, and the number of times the link was the most limiting in the as-available status. This information is commonly used by the analyst to determine the role of each task toward the success or failure of the mission. The AURA link allocation/availability methodology is described in detail in Volume 1 (Chapter 4.1) of the AURA Programmer/ Analyst Guide (Sheroke et al. 1990b). As shown in the example, the link name, link number, and associated values are listed in the columns, and the reconstitution times are reported in the rows. For example, at 120.0 min, the DRIVER/RTO (link No. 2) task, was used in all 100 replications and was weak due to asset unavailability in six of the replications.

2.4.13 Compound Link Parts vs. Time Table. Example 50 illustrates the Compound Link Parts vs. Time Table. This table provides a reference to the effective capability of the compound link parts at each reconstitution time in the scenario. In Example 50, the compound link is comprised of 10 compound link parts. Recall, the compound link is used to represent a task which is the aggregation of several subtasks, each of which is "weighted" with respect to the contribution of this subtask towards the primary task. As shown in

CONTAMINATED ASSET SURVIVORS
****

TIME	FIREME N 1	FIRETE AM 2	RECORD S 3	CRANE 4	FRKLFT 6A 5	FRKLFT 6B 6	FRKLFT 6C 7	FRKLFT 6D 8	FRKLFT 6E 9	FRKLFT 6F 10	FRKLFT 6G 11	FRKLFT 6J 12	FRKLFT 4K 13	FRKLFT 4L 14	FRKLFT 4M 15	USERS A 16	USERS B 17
0.0	0.00	0.0	0.00	0.00	0.(	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
480.0	0.00	0.0	0.00	1.00	0.0(	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
710.0	0.00	0.0	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TIME	USERS C 18	USERS D 19	USERS E 20	USERS F 21	USERS G 22	USERS K 23	USERS L 24	USERS M 25
0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
480.0	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
710.0	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00

Example 48. Contaminated Asset Survivors Table.

LINK RESULTS VS. TIME FOR REPLICATION 0

KEY :
LINE 1 = # OF ACTUAL USES (INCL. = 0 IF NOT IN CPLNK)
LINE 2 = # OF TIMES WEAK BECAUSE ASSETS UNAVAILABLE
LINE 3 = # OF TIMES WEAK, LIMITED BY NO. ALLOWED IN LINK
LINE 4 = # OF TIMES = 0 IN COMPOUND LNK (THUS NOT COUNTED IN LINE 1)
LINE 5 = # OF AS-AVAILABLE USES (AS IN REPAIR)
LINE 6 = # OF TIMES LIMITING IN AS - AVAILABLE USES

****

TIME	CO LVL DEC M KG 1	DRIVER /RTO 2	COMMO DEVICES 3	SUPPOR T ADVI CE 4	PERSON. NEL AD. MIN 5	AMMO C ARRIER 6	AMMO A. DVICE 7	ITV SU PPLY 8	ITV SU PPLY C REW 9	APC1A1 10
0.0	100	100	100	100	100	100	100	0	0	100
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
5.0	100	100	100	100	100	94	100	6	6	100
	0	0	0	0	0	0	0	6	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
120.0	100	100	100	100	100	94	100	6	6	100
	0	6	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0

Example 49. Link Results vs. Time Table.

COMPOUND LINK PARTS VS. TIME
****

AVERAGE EFFECTIVENESS USED, OVER ALL REPLICATIONS
(NOTE : IF CPL NOT WEAK, MORE CAPABILITY MAY HAVE BEEN AVAILABLE THAN WAS USED)

TIME	1	2	3	4	5	6	7	8	9	10
0.0	0.95	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
240.0	0.82	0.83	0.95	0.89	0.87	1.00	1.00	1.00	0.99	1.00
300.0	0.82	0.83	0.95	0.89	0.87	1.00	1.00	1.00	0.99	1.00
360.0	0.83	0.85	0.95	0.92	0.91	1.00	1.00	1.00	0.99	0.99
420.0	0.83	0.85	0.95	0.92	0.91	1.00	1.00	1.00	0.99	0.99
480.0	0.83	0.85	0.95	0.92	0.91	1.00	1.00	1.00	0.99	0.99
540.0	0.83	0.85	0.95	0.92	0.91	1.00	1.00	1.00	0.99	0.99

Example 50. Compound Link Parts vs. Time Table.

Example 50, the Compound Link Parts vs. Time Table reports the effectiveness value (percentage) for each compound link part. In this example, throughout all reporting times, compound link part No. 1 began at 95% effective and ended at 83% effective, while compound link part No. 6 remained at 100% effective throughout this mission. If another link exists other than the compound link, the compound link may only be optimized until it is no longer the weak link. Therefore, the values in this table may not reflect the full capability of the compound link.

2.4.14 Segment Results: Cumulative Times Weakest vs. Time Table. In AURA, the chain construct is used to represent all of the tasks required to perform a mission. Each of these tasks (or subtasks) are referred to as segments of the chain. A segment may be comprised of any construct (or combinations of constructs) which are used to represent lower echelon taskings of the mission (such as links, orlinks, etc.). Example 51 illustrates the Segment Results Table. The Segment Results Table reports the segment type which most degrades the unit as well as the number of times this segment is the "weak link" during the optimization process. In Example 51, it is shown that chain No. 1 is comprised of five segments. The third line reports the construct numbers which comprise the segment. In this case, the first segment is link No. 4, the second segment is link No. 6, the third segment is link No. 7, the fourth segment is comprised of subchain No. 1 (denoted by the preceding "*" sign), and segment No. 5 is compound link No. 1. Furthermore, it is shown that segment No. 5 was the weakest segment in all 20 optimization attempts for this mission.

2.4.15 Chain Results vs. Time Table. Example 52 reports the status of all chains at each reconstitution time throughout the mission. AURA provides the capability to specify multiple methods to perform a mission, each of which may be represented as a chain. The Chain Results vs. Time Table lists a status report of all chains used in the scenario by providing such information as the following: the average effectiveness (over all replications), the number of times the chain was the strongest, and the average effectiveness value when the chain was the strongest. In AURA, the strongest chain refers to the method of mission accomplishment with the highest effective capability. For example, suppose there are two possible methods defined to perform a mission, Method 1 (chain No. 1) and Method 2 (chain No. 2). At any given reporting time, the method producing the greater effective capability will

SEGMENT RESULTS : CUMULATIVE TIMES WEAKEST VS. TIME
****

CHAIN #!	1	1	1	1	1
SEGMENT #!	1	2	3	4	5
TIME \ TYPE !	4	6	7	*1	!1
240.0 !	0	0	0	0	20
300.0 !	0	0	0	0	20
360.0 !	0	0	0	0	20
420.0 !	0	0	0	0	20
480.0 !	0	0	0	0	20
540.0 !	0	0	0	0	20

Example 51. Segment Results vs. Time Table.

CHAIN RESULTS VS. TIME
****

AVERAGE EFFECTIVENESS
NO. OF TIMES CHAIN IS STRONGEST
(AVERAGE EFFECTIVENESS WHEN STRONGEST)
****

TIME	CHAINS 1
0.0	. 0.97
	. 20
	. (0.97)
240.0	. 0.92
	. 20
	. (0.92)
300.0	. 0.92
	. 20
	. (0.92)
360.0	. 0.93
	. 20
	. (0.93)
420.0	. 0.93
	. 20
	. (0.93)
480.0	. 0.93
	. 20
	. (0.93)
540.0	. 0.93
	. 20
	. (0.93)

Example 52. Chain Results vs. Time Table.

be the strongest chain. In Example 52, only one chain was used, resulting in the effective capability of the chain to be reported at each reconstitution time. (Had a second chain been modeled, similar information for the chain would have appeared in a column adjacent to chain No. 1.) As shown in this example, this chain began at 97% and degraded to 93% effective in accomplishing the mission over the time period considered.

2.4.16 Average Repairs on Repairable Items. The Average Repairs on Repairable Items Table (illustrated in Example 53) is produced only when modeling repair. This table reports the number of ordered (ORDERD) and completed (DONE) repairs for each level of repair. The term "ordered" refers to the total number of repairs needed and includes any reorders of discontinued repairs. In AURA, repairs are ordered based on the availability of assets. Levels of repair include decontamination (level 0) (chemical only), light (level 1), and medium (level 2) and relate to the level of damage received by an asset. For example, a lightly damaged asset requires light repair, and an asset that receives medium damage requires medium repair. A heavily damaged asset is considered unrepairable; therefore, heavy repair is not included as an entry in the table. It should be noted that these levels of repair are user-selected and relate to specific amounts of damage received as dictated by the lethality file (see AURA Input Manual and Volume 1 for further information on the AURA REPAIR methodology [Sheroke et al. 1990b; Klopcic, Sheroke, and Price 1990]).

The first column of the table contains the asset group identification number and name. Data for level 0 repairs is printed in the second and third columns only when a chemical or a combined chemical/conventional scenario is modeled. For conventional and nuclear scenarios, there will be no entries listed in the table for level 0 repairs. Example 53 is taken from a conventional run. Consequently, no data is printed for level 0 repairs. Level 1 repair data are listed in columns four and five. The remaining two columns contain the data for Level 2 repairs. In Example 53, asset No. 94, the CRANE 247, received damaged for which 0.00 light repairs have been ordered and 0.05 repairs have been completed.

2.4.17 Repair/Decontamination Summary Table. The Repair/Decontamination Summary Table, illustrated in Example 54, reports the end of encounter repair/decontamination status of equipment assets. For each equipment asset group, the following information is reported: the asset group identification number, asset group name, initial number of assets deployed in

AVAERAGE REPAIRS ON REPAIRABLE ITEMS
****

	DECON		LITE		MEDIUM	
ASSET	ORDERD	DONE	ORDERD	DONE	ORDERD	DONE
80 FORK B			1.67	0.50	1.78	1.53
81 FORK CI			3.00	2.75	0.00	0.00
82 FORK 247			0.00	0.00	0.00	0.00
92 CRANE B			0.00	0.00	0.00	0.00
93 CRANE CI			0.37	0.00	0.00	0.00
94 CRANE 247			0.00	0.05	0.00	0.00
119 OVENS			0.00	0.00	0.00	0.00
120 PUMP100			1.00	0.00	0.00	0.00
122 WATER TRLR			0.00	1.00	0.00	0.00
123 MIXER			0.00	0.00	0.00	0.00
124 FLOUR SIFTER			0.00	0.00	0.00	0.00
125 TRUCKS			0.00	0.00	0.00	0.00
126 TRUCK5L			0.00	0.00	1.00	0.00
127 TRUCK5P			2.94	0.83	0.00	0.00
132 FILTER/SEP			0.00	0.00	0.00	0.00
134 PETRO FORK			0.00	0.00	0.00	0.00

Example 53. Averaged Repairs on Repairables Table.

REPAIR/DECONTAMINATION SUMMARY
****

ASSET		INITIAL	UNHARMED	CONTAMD	LIT DAM	MED DAM
80	FUEL TANK	9.0	6.00	0.00	2.00	1.00
81	FORK CI	1.0	0.00	0.00	0.00	0.00
82	FORK 247	1.0	0.00	0.00	0.00	0.00
86	GEN5 B	1.0	0.00	0.00	0.00	0.00
87	GEN5 CI	1.0	0.00	0.00	0.00	0.00
88	GEN5 247	1.0	0.00	0.00	0.00	0.00
92	CRANE B	1.0	0.00	0.00	0.00	0.00
93	CRANE CI	1.0	0.00	0.00	0.00	0.00
94	CRANE 247	1.0	0.00	0.00	0.00	0.00
110	BSTH3	5.0	5.00	0.00	0.00	0.00
111	BKY30	1.0	1.00	0.00	0.00	0.00

Example 54. Repair/Decontamination Summary Table.

asset group, number of unharmed assets, number of contaminated assets, number of assets receiving light damage, and the number of assets receiving medium damage. In AURA, equipment damage status is categorized with respect to the level of repair required. In this example, the end of encounter status of asset group number 80 (FUEL TANKS) is as follows: There were 9.0 fuel tanks initially deployed for the mission, whereby 6.0 of the fuel tanks were unharmed throughout the mission, no fuel tanks were contaminated, 2.0 received light damage, and 1.0 fuel tank incurred medium damage. The information provided by the Repair/Decontamination Table enables the analyst to isolate causes of unit degradation that are primarily related to equipment functionality. The inoperability or contamination of equipment, as reported in this table, can also be used to measure the criticality of equipment to the mission requirements.

2.4.18 Summary of Targeting Characteristics Table. Example 55 illustrates the end-of-encounter targeting characteristics for each munition employed in the scenario. The targeting parameters, which are described below, are averaged over all replications. For each weapon, the following data are presented: the weapon number (internally assigned by AURA), the total number of rounds fired, the average *aim point coordinates*, the average burst point coordinates, and the standard deviation from the average burst point. The primary use of this table is to verify that round distribution is taking place as intended.

2.4.19 Fatigue Output - Total Accumulated. The Fatigue Output - Total Accumulated Table, illustrated in Example 56, provides the analyst with an assessment of the sleep deprivation status of unit personnel. In AURA, sleep deprivation is modeled by quantifying the amount of efficient rest (in terms of minutes) a person requires and expends in performing their job in the mission. The unit of measure used for sleep deprivation in AURA is called a sleep unit or SLUNIT. One SLUNIT = 1 min of efficient rest. This table reports the rate that SLUNITs are expended and the rate that SLUNITs are accumulated while personnel are resting. For a more detailed description of AURA's Sleep Deprivation/Fatigue Model, the user is referred to Volume 1 of the AURA Programmer/Analyst Guide (Sheroke et al. 1990b). A description of the information provided in the Fatigue Output - Total Accumulated Table is given in the following paragraph.

SUMMARY OF TARGETING CHARACTERISTICS
****

WPN. NO	NO. RNDS	MEAN DGZ	MEAN AGZ	MEAN AGZ S.D.
1	640	1281.25 1313.75	1229.48 1311.03	323.80 236.57

Example 55. Summary of Targeting Characteristics Table.

FATIGUE OUTPUT - TOTAL ACCUMULATED
****

ID	WORK (MAN-) (MIN)	WORK (MAN-) (SLUN)	REST (MAN-) (MIN)	REST (MAN-) (SLUN)	SLEND	ID	WORK (MAN-) (MIN)	WORK (MAN-) (SLUN)	REST (MAN-) (MIN)	REST (MAN-) (SLUN)	SLEND
1	60.0	31.00	30.00	30.00	1309.00	2	0.0	0.00	0.00	0.00	0.00
16	0.0	0.00	0.00	0.00	1520.00	17	0.0	0.00	0.00	0.00	1520.00
18	0.0	0.00	0.00	0.00	1520.00	19	0.0	0.00	0.00	0.00	1520.00
20	0.0	0.00	0.00	0.00	1520.00	21	0.0	0.00	0.00	0.00	1520.00

Example 56. Fatigue Output - Total Accumulated.

The Fatigue Output - Total Accumulated Table is separated into halves with identical column headers for each half. The first column, headed by "ID," contains the asset identification number. Column two has the header "WORK (MAN-) (MIN)" and reports the number of minutes worked by each asset. The next column is headed by "WORK (MAN-) (SLUN)" and provides the rate that SLUNITs are expended while working. Column four reports the amount of rest, in minutes ("REST (MAN-) (MIN)"), taken by each asset. Column 5, headed by "REST (MAN-) (SLUN)," reports the rate at which SLUNITs are accumulated while people are resting. The last column is headed by "SLEND" which translates to SLUNITs at END. This column contains the "SLUNIT balance" for each asset at the termination of the mission.

2.5 Summary. This report has presented the outputs and error diagnostics generated by the Army Unit Resiliency Analysis (AURA) computer simulation model. Through the usage of detailed examples, the AURA analyst is provided a comprehensive interpretation of the output formats, controls, and values which may result from an AURA run. The report was organized to enable the analyst to peruse the AURA tables in the general sequence that they occur in the output.

Beyond the scope of this report are techniques for developing descriptions of unit operations and strategies for input preparations. These topics, in addition to modeling considerations, will be addressed in Volume 3 of the AURA Programmer/Analyst Guide (Sheroke et al., to be published).

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APPENDIX:

WARNING AND ERROR DIAGNOSTICS

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This appendix describes the warnings and fatal error messages which may occur in an AURA run. The warning diagnostics produced by AURA are informative messages indicating a logical disagreement or syntactical nonconformity in AURA and do not affect the successful completion of the AURA run. List No. 1 is a numerical listing of all AURA warning diagnostics. Included for each warning and error diagnostic described in this appendix is the following information:

- Recommended solution to resolve cause of warning or error;
- Reference to appropriate command format in input manual (if applicable);
- Subroutine from which warning diagnostic occurred.

The error diagonstics produced by AURA are defined as those errors which abruptly terminate the run. The error diagnostics generally fall into the following two categories: command syntax errors and logical errors. Command syntax errors result from a flaw in the usage or format of an AURA input command. Logical errors occur as a result of incorrect or inappropriate modeling techniques. Each error diagnostic produced by AURA provides information relating to the reason(s) of the error's occurrence. List No. 2 is a numerical listing of all error diagnostics coupled with information presented in the same format described for warning messages.

<u>List No. 1</u>

1) ** WARNING-1 ** CAN ONLY SUPPORT 50 SIMULTANEOUS REPAIR ACTIONS, REPAIR INPUT CHANGED.

   a) AURA will only use the first 50 repair actions declared.
   b) Check parameters in REPAIR mnemonic card.
   c) See subroutine RPRIN.

2) ** WARNING-2 ** END CARD MISSING AFTER ____.

   a) User omitted END card after specified data set in runstream; END card is essential after NAMES data.

b) See appropriate mnemonic card.

c) See AURA Volume I and II for appropriate subroutine.

3) ** WARNING-3 ** ASSET LIST DOES NOT INCLUDE ______.

a) Asset name found has not been declared in the ASSET section.

b) Asset must be listed under ASSETS heading in runstream.

c) Check parameters in NAMES mnemonic card.

d) See subroutine FINDFG.

4) ** WARNING-4 ** POSTURE OR KILL CRITERIA FOR ID, DIFFERS BETWEEN DEPLOYMENT PTS.

a) Same asset has different posture or kill criteria at different deployment points.

b) Check parameters in DEPLOYMENT and NAMES mnemonic cards.

c) See subroutine DEPCHK.

5) ** WARNING-5 ** NO LETHALITY DATA WAS READ FOR WEAPON NUMBER ______.

a) Check runstream and appropriate lethality file whether toxic, nuclear, or conventional to verify matching weapon names.

b) Check runstream to ensure that the appropriate lethality mnemonic card was input, i.e., CONVENTIONAL LETHALITY, TOXIC DISPERSION, NUCLEAR VULNERABILITY.

c) Check parameters in NAMES and WEAPON mnemonic cards.

d) See subroutine WEPCHK.

6) ** WARNING-6 ** VOLLEY MUST CONTAIN MORE THAN 1 ROUND.

a) Use ROUND mnemonic card to simulate one incoming round.

b) Check parameters in VOLLEY mnemonic card.

c) See subroutine VLLYIN.

7) ** WARNING-7 ** PERSISTENCE TIME OF TOXIC WEAPON DISPERSION # ___ IS LONGER THAN ENCOUNTER TIME. ONCE INTO MOPP, PERSONNEL WILL NOT GET OUT.

a) To analyze unit effectiveness after personnel return to original MOPP, include a reconstitution event at a point in time beyond the persistence time of the agent.
b) Check parameters in PERSISTENCE, WEAPON, MOPP, and RECONSTITUTION mnemonic cards.
c) See subroutine CLDTIM.

8) ** WARNING-8 ** THE PARTS OF COMPOUND LINK SUM TO _____.

a) Change the weighting of each task so that they sum to one.
b) Check parameters in COMPOUND LINKS mnemonic card.
c) See subroutine CPLKIN.

9) ** WARNING-9 ** CONTAMINATED ITEM USAGE DOES NOT REQUIRE ALL PERSONNEL TO BE IN MOPP.

a) The CONTAMINATED USAGE card has been used. If no MOPP safe posture has been identified in the runstream (see MOPP ALL), exposed personnel will be allowed to continue operations with contaminated equipment. This may not be realistic. Furthermore, the contact hazard of using contaminated items is not modeled. Chemical casualties may be underestimated.
b) Check parameters in CONTAMINATED USAGE, MOPP, and DEPLOYMENT mnemonic cards.
c) See subroutine DEPCHK.

10) ** WARNING-10 ** ONLY ONE STOCHASTIC PK IS DRAWN PER TARGET POINT ITEMS AT TGT PT WILL BE KILLED AS A GROUP NOT INDEPENDENTLY.

a) Items should be deployed at different deployment points when using the stochastic mode.
b) Check parameters in MODE and DEPLOYMENT mnemonic cards.
c) See subroutine DEPCHK.

11) ** WARNING-11 ** CONTAMINATED ITEMS MAY NEVER BE USED SINCE PERSONNEL TARGET POINT HAS NO MOPP-SAFE POSTURE.

a) Modeling an unprotected scenario to assess casualities without MOPP-safe posture while permitting use of contaminated items which cannot be used by personnel in less than MOPP4.
b) Unit effectiveness may be underestimated since personnel cannot use contaminated items to perform their mission.
c) Check parameters in CONTAMINATED USAGE, MOPP, and DEPLOYMENT mnemonic cards.
d) See subroutine DEPCHK.

12) ** WARNING-12 ** HEAT STRESS PROBABILITY = 0, FOR TOXIC K.C. ____ IN MOPP ___. EASY JOB OR COLD DAY?

a) Heat stress is not turned on or parameters set too low? If cold day or easy job, heat stress need not be modeled.
b) Check parameters in HEAT STRESS mnemonic card.
c) See subroutine DEPCHK.

13) ** WARNING-13 ** MAXIMUM RECONSTITUTION TIME = _____, BUT SOME ASSET NEEDS ____ FOR SOME SUBSTITUTION. THEREFORE, SOME SUBSTITUTION WILL NEVER BE MADE EXCEPT AT INITIAL TIME.

a) Check substitution times.
b) Add additional reconstitutions around the maximum time at end of simulation to allow slow substitutions.

c) Check parameters in RECONSTITUTION EVENTS and LINKS mnemonic cards.

d) See subroutine ENCCHK.

14) ** WARNING-14 ** REINFORCEMENT AT TIME _____ OCCURS WITHIN INTERNAL RECONSTITUTION TIME OF LETHALITY EVENT AT TIME _____.

a) Time of reinforcement may be inappropriate in relation to event times.

b) Check parameters in REINFORCEMENTS/LOSSES mnemonic card.

c) See subroutine EVNTBL.

15) ** WARNING-15 ** THE MEAN TIME BETWEEN FAILURES FOR ID ___ IS SHORT.

a) User may want to insert more reconstitution events into time gap to prevent too many failures sitting idle before repairs are processed.

b) Mean time between failures may be wrong.

c) Check parameters in FAILURE RATE and RECONSTITUTION EVENTS mnemonic cards.

d) See subroutine FAICHK.

16) ** WARNING-16 ** NO REPAIRS FOR ITEMS WHICH CAN FAIL REPAIRABLY.

a) Repairs of failed equipment need not be modeled.

b) Consider using repair links, if appropriate.

c) Check parameters in REPAIR mnemonic card.

d) See subroutine FAICHK.

17) ** WARNING-17 ** THE FATIGUE OPTION CURRENTLY KEEPS ONLY AVERAGES OF SLEEP TIME OVER ASSET GROUPS. ACCOUNTING IS PRECISE FOR ASSET GROUP OF ONE, BUT APPROXIMATE FOR OTHERS.

a) To be more precise, select unique names for all personnel assets.

b) Check parameters in ASSETS and FATIGUE mnemonic cards.

c) See subroutine FGCHK.

18) ** WARNING-18 ** GRANULARITY .LT. 0.0001 MAY RESULT IN ROUND-OFF ERRORS.

a) Increase input granularity in mnemonic card to avoid round-off errors.
b) Check parameters in GRANULARITY mnemonic cards.
c) See subroutine GRANIN.

19) ** WARNING-19 ** LINK ____ HAS MORE ITEMS THAN ALLOWED BY ITS MAX IN.

a) Reduce number of assets for LINK ____.
b) Deploy assets under different name; make link a DUMMYLINK.
c) Check parameters in LINKS, DEPLOYMENT, and NAMES mnemonic cards.
d) See subroutine LNKCHK.

20) ** WARNING-20 ** DUMMY LINK NOT FOLLOWED BY SUBSTITUTES. CHECK LINK INPUT.

a) Is this meant to be a DUMMY LINK?
b) Check parameters in LINKS mnemonic card.
c) See subroutine LNKIN.

21) ** WARNING-21 ** SOME LINKS HAVE NO CORRESPONDINGLY NAMED ASSET(S). ASSUMING "DUMMY LINK(S)" SEE HOME IDS IN LINK DEFINITION TABLE.

a) If not intended to be a DUMMY LINK, add name to asset list.
b) The LINK describes a task only and not a particular asset.
c) To assure the modeling of a HOMELINK, a link name must be identical to the asset name which has the primary responsibility for completing the link task.
d) Check parameters in LINKS mnemonic cards.
e) See subroutine LNKIN.

22) ** WARNING-22 ** AT LEAST ONE LINK OPTIMIZATION TERMINATED BECAUSE ADDITION OF (DEGRADED?) ASSETS RESULTED IN INSUFFICIENT IMPROVEMENT, DETAILS WRITTEN ON FILE 8 IF "DUMP8" IS ON (UNDER "OUTPUT" MNEMONIC).

a) Code was forced to use increasingly inefficient assets. Reached efficiency cut-off. Unit effectiveness may be slightly underestimated.
b) See subroutine LNKOPT.

23) ** WARNING-23 ** WEAPON ___ HAS <= 0. ROUND-ROUND RELIABILITY.

a) ROUND-ROUND reliability should be between zero and one.
b) Check parameters in RELIABILITY mnemonic cards.
c) See subroutine RELIIN.

24) ** WARNING-24 ** WEAPON ___ HAS <= 0. VOLLEY RELIABILITY.

a) Volley reliability should be between zero and one.
b) Check parameters in RELIABILITY mnemonic cards.
c) See subroutine RELIIN.

25) ** WARNING-25 ** NUMBER OF REPLICATIONS EXCEEDS PACKING CONSTANT FOR WEAK SEGMENT STORAGE. WEAK SEGMENT COUNT COULD BE QUITE CONFUSED BY CHRONICALLY WEAK SEGMENT.

a) Reduce number of replications.
b) Ignore weak segment count.
c) Check parameters in LINKS and REPLICATIONS mnemonic cards.
d) See subroutine REPLIN.

26) ** WARNING-26 ** YIELD OF NUCLEAR WEAPONS IS LESS THAN OR EQUAL TO ZERO.

a) Check parameters in YIELD mnemonic cards.

b) See subroutine RESTIN.

27) ** WARNING-27 ** FROM REPAIR CHECK ROUTINE**** REPAIRS AND DECONTAMINATIONS CAN ONLY BE INITIATED AT A RECONSTITUTION EVENT. SINCE THE LARGEST TIME BETWEEN RECONST. EVENTS IS SIGNIFICANT COMPARED TO THE REPAIRS LISTED BELOW, IT IS POSSIBLE FOR A REPAIR TO FINISH AND THE REPAIR ASSETS TO SIT IDLE FOR SIGNIFICANT TIMES BEFORE BEING REASSIGNED. IF SUCH IDLE TIME WOULD BE AN UNREAL FACTOR IN THIS STUDY, THE REMEDY IS TO PUT RECONSTITUTION EVENTS INTO THE SMALL TIME GAPS.

a) Add additional reconstitution times.

b) Check parameters in RECONSTITUTION EVENT and REPAIR mnemonic cards.

c) See subroutine RPRCHK.

28) ** WARNING-28 ** NO REPAIR LINKS GIVEN FOR ID _____.

a) If playing repair, ensure link has correct parameters.

b) Item may not be repairable type.

c) See parameters in REPAIR and LINK mnemonics cards.

d) See subroutine RPRIN.

29) ** WARNING-29 ** DOES NOT IDENTIFY A UNIQUE ASSOCIATED ASSET FOR NUCLEAR POSTURE. ID ___ WAS ARBITRARILY SELECTED AS THE UNIQUE CHOICE.

a) Nuclear Blast Vulnerability parameters for asset ID ___ will be used by code for this asset.

b) If desired, input a unique associated asset for ID ___.

c) See parameters in SHLDIN mnemonic card.

d) See subroutine SHLDIN.

30) ** WARNING-30 ** SETTING RECONSTITUTION YES AFTER THE MOPP MNEMONIC NEGATES THE EFFECT OF THE PROXIMITY OPTION.

a) RECONSTITUTION YES forces the code to put all personnel in MOPP 4, thereby negating the proximity option.

b) The use of RECONSTITUTION YES option has become obsolescent in view of the many code updates which have been made to improve chemical modeling.

c) See parameters in MOPP and RECONSTITUTION EVENT.

d) See subroutine TOXCHK.

31) ** WARNING-31 ** TIME INTERVAL BETWEEN SHORTEST MOPP TIME AND DOSAGE UPDATE TIME FOR TOXIC WEAPON IS TOO LONG.

a) Currently, NUSSE provides dose and dosage data for only five times of interest. When assessing the dosages of personnel at the target across time, AURA will be forced to interpolate on the data provided by NUSSE across these times. The analyst must choose NUSSE times of interest wisely.

b) Adjust NUSSE times of interest to be close to times of interest for chemical modeling in AURA.

c) Dosage levels and/or casualties may be underestimated.

d) See parameters in TOXIC DISPERSION DATA, MOPP, and RECONSTITUTION mnemonic cards.

e) See subroutine TOXCHK.

32) ** WARNING-32 ** NO DATA FOR TOXIC WEAPON NUMBER.

a) Incorrect or insufficient data in the chemical lethality file (Tape 4).

b) Has the TOXIC DISPERSION DATA mnemonic been included in the runstream?

c) Check parameters in WEAPONS mnemonic card.

d) See subroutine TOXIN.

33) ** WARNING-33 ** NUKE HAS <=0. BLAST YIELD.

a) Check value input under YIELD mnemonic card. It should be greater than 0.

b) See subroutine YLDIN.

34) ** WARNING-34 ** NUKE HAS <=0. RAD. YIELD.

a) Check value input under YIELD mnemonic card. It should be greater than 0.

b) See subroutine YLDIN.

35) ** WARNING-35 ** COULD NOT FIND ASSET NAMED ON SOME DEPLOYMENT CARD(S). "DUMMY LINK(S)" CREATED. SEE IDS IN DEPLOYMENT TABLE.

a) If not intended to be a DUMMY LINK, add name to asset list.

b) The LINK describes a task only and not a particular asset.

c) To assure the modeling of a HOMELINK, a link name must be identical to the asset name which has the primary responsibility for completing the link task.

d) Check parameters in LINKS mnemonic cards.

e) See subroutine DEPLIN.

<u>List No. 2</u>

1) ** ERROR-1 ** (ADDITIONAL) ERRORS IN INPUT FORMATS. DETAILS PRINTED WITHIN LISTING OF MNEMONICS AT BEGINNING OF THIS OUTPUT.

a) Look in preceding section of output (where mnemonics are printed) for listing of errors.

b) See subroutine ENCCHK.

2) ** ERROR-2 ** AGENT TYPE FOR WEAPON ____ NOT ALLOWED.

a) G or GB, V or VX, H or HD are currently allowable agent types.

b) Must use one of three agent types permitted within AURA.

c) Check parameters in AGENT mnemonic card.

d) See subroutine AGNTIN.

3) ** ERROR-3 ** ASSET #___ IS BEING USED AS BOTH DUMMY LINK AND HOMELINK. ILLEGAL. FATAL ERROR IN DEPLOY.

a) Current procedure does not require listing of dummy link in ASSETS. Any link that is deployed, but not identified as an asset, is automatically classed as a dummy link.

b) Check parameters in DEPLOYMENT mnemonic card.

c) See subroutine DEPLIN.

4) ** ERROR-4 ** AMBIGUOUS ASSET NAME _____ CANNOT BE AN INPUT FOR EXPENDABLE. STOP IN XPNDIN.

a) Asset must be an unique (first) name. Redefine asset name under EXPENDABLE card using a unique name and not a secondary name.

b) Check parameters in EXPENDABLE mnemonic card.

c) See subroutine XPNDIN.

5) ** ERROR-5 ** CANNOT INTERPOLATE BETWEEN LESS THAN 2 DATA. STOP IN BRCKT2.

a) Check toxic lethality input file for missing data.

b) Error in PRETOX output or NUSSE output?

c) See subroutine BRCKT2.

6) ** ERROR-6 ** CANNOT IDENTIFY WHICH IS BEING USED AS A CHAIN SEGMENT.

a) Check CHAIN input.

b) Check parameters in CHAINS mnemonic card.

c) See subroutine CHNIN.

7) ** ERROR-7 ** CHAINS MUST BE DESIGNATED BEFORE THE "REPAIR" OPTION CAN BE USED.

a) Check placement of CHAIN card in runstream.
b) See REPAIR and CHAINS mnemonic cards.
c) See subroutine RPRIN.

8) ** ERROR-8 ** CLOTHING PARAMETERS REQUIRE MOPP LEVEL AND PARAMETER VALUE.

a) Insert clothing parameters, MOPP level, and parameter values under HEAT STRESS card.
b) See input manual for format of HEAT STRESS input.
c) See subroutine HTSTIN.

9) ** ERROR-9 ** COULD NOT FIND LINK ____, (LINK INPUT MUST PRECEDE REPAIR). STOP IN RPRIN.

a) Check order of LINKS and REPAIR mnemonic cards in runstream.
b) Link name may either be misspelled or not included. If needed, add link to LINKS section.
c) Check parameters in LINKS and REPAIR mnemonic cards.
d) See subroutine RPRIN.

10) ** ERROR-10 ** CUMNRM CALLED WITH ILLEGAL VARIANCE = ___. STOP CALLED FROM CUMNRM.

a) Variance values must be positive. Since variance is square of (usual) standard deviation type inputs, this error might indicate code malfunction.
b) See subroutine CUMNRM.

11) ** ERROR-11 ** DIMENSION TROUBLE. TEMPORARY STORAGE (MS1-MS6) IS ALSO USED FOR TEMPORARY TARGET POINTS IN LETHAL. BUT 6 * MDX(3)IS .LT. TARGET FG (TGT PTS VS. ASSETS). STOP IN NDXSET.

a) May need to increase array dimensions. If this is not possible, reduce number of target points.
b) See subroutines NDXSET.

12) ** ERROR-12 ** DEPLOYMENT BY SECONDARY NAME IS NOT ALLOWED. USE PRIMARY NAME FOR DEPLOYMENT.

a) Must deploy target using unique (first) name in asset list.
b) Check parameters in DEPLOYMENT mnemonic card.
c) See subroutine DEPLIN.

13) ** ERROR-13 ** ____ *DOES NOT IDENTIFY A UNIQUE WEAPON.*

a) Must identify weapon by unique (first) name when specifying use (via ROUND or VOLLEY).
b) Check parameters in WEAPONS mnemonic card.
c) See subroutine RNDIN.

14) ** ERROR-14 ** ERROR IN AGENT TYPE INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of agent type input in runstream, AGENT card.
d) Must use one of three, currently allowable agent types.
e) See input manual for proper format of AGENT inputs.
f) See subroutine AGNTIN.

15) ** ERROR-15 ** ERROR IN ALARM INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of ALARM input in runstream.
d) See input manual for proper format of ALARM inputs.
e) See subroutine ALRMIN.

16) ** ERROR-16 ** ERROR IN CHAIN INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of CHAIN input in runstream.
d) See input manual for proper format of CHAIN inputs.
e) See subroutine CHNIN.

17) ** ERROR-17 ** ERROR AFTER CONTAMINATED USAGE CARD. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of CONTAMINATED USAGE input in runstream.
d) See input manual for proper format of CONTAMINATED USAGE inputs.
e) See subroutine CNTUIN.

18) ** ERROR-18 ** ERROR IN CNVDMG. ATTEMPTED DATA TYPE 1 OR 4,
WEAPON, ASSET, HOB, COVER, KILL = _____.

a) Data type one and four are now being used for smart munitions. Change lethality input code number on input file (unit 2).
b) See input manual for format and data types allowed.
c) See subroutine CNVDMG.

19) ** ERROR-19 ** ERROR! WEAPON ____ AGAINST TARGET ____ HAS LETHAL RADII = 0. ILLEGAL. (PK MAY = 0; NOT RADII).

a) Correct data input. For negligible lethal radii use a value on the order of 0.01.
b) Check parameters in CONVENTIONAL LETHALITY DATA mnemonic card.
c) See subroutine CONVIN.

20) ** ERROR-20 ** ERROR! WEAPON ____ AGAINST TARGET ____. RADII MUST IN NONDECREASING ORDER.

a) See input manual for proper format. Make necessary changes to conventional lethality file.
b) Check parameters in CONVENTIONAL LETHALITY DATA mnemonic card.
c) See subroutine CONVIN.

21) ** ERROR-21 ** ERROR IN CONVENTIONAL LETHALITY INPUT.

a) Check format and syntax of lethality input in runstream.
b) See input manual for proper format.
c) Check parameters in CONVENTIONAL LETHALITY DATA mnemonic card.
d) See subroutine CONVIN.

22) ** ERROR-22 ** CANNOT USE A COMPOUND LINK AS A PART OF A COMPOUND LINK.

a) Redefine functional structure.
b) Check parameters in COMPOUND LINKS mnemonic cards.
c) See subroutine CPLKIN.

23) ** ERROR-23 ** ERROR IN COMPOUND LINK INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.

c) Check format and syntax of COMPOUND LINKS input in runstream.

d) See input manual for proper format.

e) See subroutine CPLKIN.

24) ** ERROR-24 ** ERROR IN CREW INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of CREW input in runstream.

d) See input manual for proper format.

e) See subroutine CRWIN.

25) ** ERROR-25 ** REPAIRABLE ASSET #___, HAS LIGHT/MEDIUM/HEAVY DAMAGE LETHALITY FOR WEAPON # __BUT NOT FOR OTHER WEAPONS. MUST HAVE FOR ALL OR NONE.

a) Update each weapon with the same type of input in the conventional lethality file.

b) Check parameters in CONVENTIONAL LETHALITY DATA mnemonic card.

c) See subroutine CVLCHK.

26) ** ERROR-26 ** ERROR AFTER DECISION CARD. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of input after DECISION RULES card in runstream.

d) See input manual for proper format.

e) See subroutine DCSRLN.

27) ** ERROR-27 ** ERROR IN TOXIC DEGRADATION INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of DEGRADATION input.

d) See input manual for proper format.

e) See subroutine DEGRIN.

28) ** ERROR-28 ** ID# __ WAS INPUT AS A SECONDARY EXPLOSIVE. IT CANNOT BE IN A LINK. RUN CHANGED TO DEBUG.

a) Secondary explosion is not a task. Remove from LINKS section.

b) Check parameters in ASSETS and WEAPON mnemonic cards.

c) See subroutine DEP2ND.

29) ** ERROR-29 ** SECONDARY EXPLOSIVE ID #__, WAS DEPLOYED BY USER AT TARGET POINT. ILLEGAL. RUN CHANGED TO DEBUG.

a) Secondary explosive need not be deployed. The location of an asset which has been defined as having the potential to become a secondary explosion needs to be deployed.

b) See subroutine DEP2ND.

30) ** ERROR-30 ** ERROR ON DELIVERY ERROR INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of DELIVERY ERROR input in runstream.

d) See input manual for proper format.

e) See subroutine DLVRIN.

31) ** ERROR-31 ** TARGET POINT ____ CONTAINS A DUMMY LINK ____ WHICH HAS NO SUBSTITUTES. SUCH A LINK CANNOT BE DEPLOYED!!!

a) A DUMMY LINK which has no substitutes may not be deployed. Either add substitutes or don't deploy it.

b) See subroutine DUMCHK.

32) ** ERROR-32 ** ____ WAS DEPLOYED AT TARGET POINT ____, BUT WAS NOT INPUT AS AN ASSET OR A LINK.

a) Define entity deployed at target point as an ASSET or a LINK or both.
b) See subroutine DUMCHK.

33) ** ERROR-33 ** ERROR IN FAILURE INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of FAILURE RATE input in runstream.
d) See input manual for proper format.
e) See subroutine FAILIN.

34) ** ERROR-34 ** ASSET NAMED ____ HAS MORE THAN ONE ELEMENT. CURRENTLY NOT ALLOWED FOR PERSONNEL IN STOCHASTIC MODE.

a) Two or more assets can be deployed at the same point, but they must have unique names in order to run stochastic mode.
b) Check parameters in ASSET and MODE mnemonic cards.
c) See subroutine FGCHK.

35) ** ERROR-35 ** ERROR IN GRANULARITY INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of GRANULARITY input in runstream.
d) See input manual for proper format.
e) See subroutine GRANIN.

36) ** ERROR-36 ** ERROR IN HEAT STRESS INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of HEAT STRESS input in runstream.
d) See input manual for proper format.
e) See subroutine HTSTIN.

37) ** ERROR-37 ** DO NOT HAVE A METEOROLOGICAL INTERVAL THAT INCLUDES THE RECONSTITUTION AT TIME ____. STOP IN HTSTR.

a) Adjust starting and stopping times of meteorological period under HEAT STRESS card so that all reconstitution times occur within some meteorological interval.
b) See subroutine HTSTR.

38) ** ERROR-38 ** ERROR IN READING DOSE-TIME DEGRADATION DATA ON UNIT 11. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Format for the DEGRADATION data in unit # 11 is provided in Appendix B in Volume II of AURA Programmer/Analyst Guide.
d) See subroutine IDPIN.

39) ** ERROR-39 ** ERROR IN NUKE DEGRADATION - LINK ASSOCIATION INPUT IS NOT KNOWN AS A LINK (LINKS MUST BE INPUT FIRST).

a) Change order of input runstream to input LINKS first.
b) See subroutine IDPIN.

40) ** ERROR-40 ** ERROR IN SUBLETHAL DOSE DEGRADATION INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of SUBLETHAL DOSE DEGRADATION input in runstream.
d) See input manual for proper format.
e) See subroutine IDPIN.

41) ** ERROR-41 ** ERROR AFTER INTERNAL CARD. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of input after INTERNAL RECONSTITUTION TIMES card in runstream.
d) See input manual for proper format.
e) See subroutine INTNIN.

42) ** ERROR-42 ** ERROR IN HEAT STRESS INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of HEAT STRESS input in runstream.
d) See input manual for proper format.
e) See subroutine IVDIN.

43) ** ERROR-43 ** LINK ___ HAS BOTH PERSONNEL AND NONPERSONNEL. NOT ALLOWED.

a) Reconfigure links. Personnel cannot substitute for nonpersonnel and vice versa. Check LINKS section in runstream.
b) See subroutine LNKCHK.

44) ** ERROR-44 ** THE NAME _____ DOES NOT UNIQUELY IDENTIFY ONE ASSET FOR LINK DEFINITION. ILLEGAL. RUN CHANGED TO DEBUG BY LNKIN.

a) Must use unique name and not a secondary name. Check names under ASSETS mnemonic card in runstream.
b) See input manual for proper format.
c) See subroutine LNKIN.

45) ** ERROR-45 ** FIRST CARD AFTER LINKS CARD MUST CONTAIN A LINK NAME (NOT A $).

a) Check format of LINK input in runstream.
b) See input manual for proper format.
c) See subroutine LNKIN.

46) ** ERROR-46 ** ERROR IN INPUT OF ASSOCIATED LINK FOR LINK ___. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of LINKS input in runstream.
d) See input manual for proper format.
e) See subroutine LNKIN.

47) ** ERROR-47 ** ERROR AFTER LINKS CARD IN SUBSTITUTES FOR LINK _____.

a) Check format and syntax of substitutes input in runstream.
b) See input manual for proper format.
c) See subroutine LNKIN.

48) ** ERROR-48 ** A LINK NAMED ____ WAS INPUT AS AN ASSOCIATED LINK FOR LINK ___, BUT WAS NEVER DEFINED.

a) Define associated link in the LINKS section of runstream.
b) See input manual for proper format.
c) See subroutine LNKIN.

49) ** ERROR-49 ** ERROR IN LINKS INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of LINKS input in runstream.
d) See input manual for proper format.
e) See subroutine LNKIN.

50) ** ERROR-50 ** ERROR IN LINK INPUT. SUBSTITUTION CARD FOR LINK ____ NOT FOLLOWED BY PROPER SUBSTITUTION TIMES AND SUBSTITUTABILITY CARDS.

a) Check format and syntax of LINKS input in runstream. Effectiveness and substitution time input must follow each substitute input in runstream.
b) Check that the number of each set of descriptions is correct.
c) See input manual for proper format.
d) See subroutine LNKIN.

51) ** ERROR-51 ** ERROR IN LINK INPUT FOR LINK ____. EFFECTIVENESS CANNOT DECREASE WITH ADDITIONAL ALLOCATION.

a) Maximum effectiveness cannot be less than minimum effectiveness.
b) Check format and syntax of LINKS input in runstream.
c) See subroutine LNKIN.

52) ** ERROR-52 ** ERROR IN LINK INPUT FOR LINK ____. MAXIMUM EFFECTIVENESS = 0.0. PROBABLE ERROR IN INPUT FORMAT.

a) Check effectiveness input. Maximum effectiveness cannot be zero.
b) Check format and syntax of LINKS input in runstream.
c) See subroutine LNKIN.

53) ** ERROR-53 ** ERROR IN LINK INPUT FOR LINK ____. NUMBER FOR MAXIMUM CAPABILITY CANNOT BE LESS THAN MINIMUM.

a) Check link input in runstream.
b) Check format and syntax of LINKS input in runstream.
c) See subroutine LNKIN.

54) ** ERROR-54 ** ID ___ HAS MORE THAN ONE HOMELINK.

a) There can only be one HOMELINK for each link. Check LINKS input.
b) See subroutine LNKSET.

55) ** ERROR-55 ** ERROR IN LETHAL DOSE INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of DOSE PARAMETERS input in runstream.
d) See input manual for proper format.
e) See subroutine LTHDIN.

56) ** ERROR-56 ** ERROR IN INPUT IN DOSE BINS (UNDER DOSE PARAMETERS MNEMONIC). MUST HAVE TEN BIN VALUES.

a) Check format of DOSE PARAMETERS input in runstream.
b) See subroutine LTHDIN.

57) ** ERROR-57 ** LAST POINTER (MDX(24)) INTO COMMON BLOCK /MAGNUS/ = , EXCEEDS SIZE OF RA ARRAY EVEN BEFORE WEAPON EFFECTS DATA AND DYNAMIC STORAGE BEGINS!!!

a) Increase dimensions of array RA.
b) See subroutine MACSET.

58) ** ERROR-58 ** ERROR ON MISS DISTANCE INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of MISS DISTANCE input in runstream.
d) See input manual for proper format.
e) See subroutine MISDIN.

59) ** ERROR-59 ** ERROR AFTER MODE CARD. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of input after MODE card in runstream.
d) See input manual for proper format.
e) See subroutine MODEIN.

60) ** ERROR-60 ** ERROR IN MOPP INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of MOPP input in runstream.
d) See input manual for proper format.
e) See subroutine MOPPIN.

61) ** ERROR-61 ** ASSET # __ HAS NO UNIQUE NAME.

a) Each asset must have at least one unique name. Insert unique name under NAMES card for asset.
b) See subroutine NAMES.

62) ** ERROR-62 ** ERROR IN SUBROUTINE NORMAL, NUM = ____.

a) Internal code error.
b) Random numbers are generated through subroutine UNIFORM. See uniform for possible program error.
c) See subroutine NORMAL.

63) ** ERROR-63 ** ERROR SPECIFYING OUTPUT OPTIONS, ERRANT CARD _____.

a) Check format of output options. See input manual for format of OUTPUT options.
b) See input manual for proper format.
c) See subroutine OOPTIN.

64) ** ERROR-64 ** NO CHAIN WAS OPERANT. ERROR AT RECONSTITUTION TIME _____.

a) No chain specified for reconstitution. Check chain inputs and chain operant times if used.
b) See subroutine OPTMIZ.

65) ** ERROR-65 ** CANNOT USE A COMPOUND LINK AS A BRANCH OF AN ORLINK.

a) Redefine functional structure.
b) Check parameters in LINKS and ORLINK input.
c) See subroutine ORLIN.

66) ** ERROR-66 ** ERROR IN ORLINK INPUT. FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of ORLINKS input in runstream.
d) See input manual for proper format.

e) See subroutine ORLIN.

67) ** ERROR-67 ** ID# ___WAS INPUT AS SECONDARY EXPLOSIVE, IT CANNOT BE IN A LINK. RUN CHANGED TO DEBUG.

a) Secondary explosions can only be input as a weapon and an asset.
b) See subroutine PRE2ND.

68) ** ERROR-68 ** SECONDARY EXPLOSIVE ID# ___ WAS DEPLOYED BY USER AT TARGET POINT. ILLEGAL. RUN CHANGED TO DEBUG.

a) Assets that are potential sources of secondary explosions must be deployed.
b) See subroutine PRE2ND.

69) ** ERROR-69 ** REPAIR OF ID __ REQUIRES LINK __ TWICE. ILLEGAL. RUN CHANGED TO DEBUG BY PRECHK.

a) A link may never be used twice in the same chain. Specify two different links.
b) See subroutine RPRCHK.

70) ** ERROR-70 ** ERROR IN PERSISTENCE MULTIPLIER INPUT, FAULTY CARD [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of PERSISTENCE input in runstream.
d) See input manual for proper format.
e) See subroutine PRSFIN.

71) ** ERROR-71 ** NO TOXIC DATA FOR ____. REMEMBER TOXIC DISPERSION CARD (WHICH CAUSES UNIT 4 TO BE READ) MUST PRECEDE PERSISTENCE INPUT.

a) TOXIC DISPERSION mnemonic card must come before the PERSISTENCE mnemonic card in the runstream.

b) See subroutine PRSFIN.

72) ** ERROR-72 ** ERROR IN RECONSTITUTION EVENT INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of RECONSTITUTION EVENTS input in runstream.

d) See input manual for proper format.

e) See subroutine RECIN.

73) ** ERROR-73 ** REINFORCEMENT WAS NOT DEPLOYED. CODE HAS NO PLACE TO PUT ASSET WHEN IT ARRIVES.

a) Reinforcement assets must be declared under the ASSET mnemonic and deployed like other assets.

b) See input manual for proper format.

c) See subroutine REICHK.

74) ** ERROR-74 ** ERROR IN REST INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of REST input in runstream.

d) See input manual for proper format.

e) See subroutine RESTIN.

75) ** ERROR-75 ** NUMBER OF WEAPON EMPLOYMENTS EXCEEDS MAX(290). STOP IN ROUND INPUT.

a) Reduce the number of weapons to less than 290.

b) See subroutine RNDIN.

76) ** ERROR-76 ** ERROR AFTER SEEDS CARD. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of input after SEEDS card in runstream.
d) See input manual for proper format.
e) See subroutine RNSDIN.

77) ** ERROR-77 ** ERROR IN PROGRAM. REPAIR SUBROUTINE CALLED FOR NONREPAIRABLE ITEM. ASSET #, DAMAGE LEVEL, CODE NUMBER.

a) Check that asset is not personnel. Verify assets in ASSETS mnemonic.
b) See subroutine RPORDR.

78) ** ERROR-78 ** GENERAL REPAIR CARD NOT FOLLOWED BY $LINK, LEVEL OR $SUBCHAIN, LEVEL.

a) Check format and syntax of repair input in runstream.
b) See input manual for correct format of REPAIR input.
c) See subroutine RPRIN.

79) ** ERROR-79 ** ERROR AFTER REPAIR CARD. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of input after REPAIR card.
d) See input manual for proper format.
e) See subroutine RPRIN.

80) ** ERROR-80 ** SUBCHAINS MAY ONLY CONTAIN LINKS OR CREWS. FAULTY ITEM [ ].

a) Redefine functional structure.

b) Check parameters in SUBCHAINS input in runstream.

c) See subroutine SBCIN.

81) ** ERROR-81 ** ERROR IN SUBCHAIN INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of SUBCHAINS input in runstream.

d) See input manual for proper format.

e) See subroutine SBCIN.

82) ** ERROR-82 ** NUCLEAR POSTURE CODE #1 MUST BE "OPEN".

a) Possible typographical error. Check nuclear posture inputs in nuclear vulnerability file.

b) See input manual for proper format of SHIELDING inputs.

c) See subroutine SHLDIN.

83) ** ERROR-83 ** NUCLEAR POSTURE CODE #2 MUST BE "OPEN-NO THERMAL EXPOSURE".

a) Possible typographical error. Check nuclear posture inputs in nuclear vulnerability file.

b) See input manual for proper format of SHIELDING inputs.

c) See subroutine SHLDIN.

84) ** ERROR-84 ** NUCLEAR POSTURE CODE #3 MUST BE "FOXHOLE".

a) Possible typographical error. Check nuclear posture inputs in nuclear vulnerability file.

b) See input manual for proper format of SHIELDING inputs.

c) See subroutine SHLDIN.

85) ** ERROR-85 ** NUCLEAR POSTURE CODES 1-3 (OPEN, OPEN - NO THERMAL, FOXHOLE) MAY NOT HAVE AN ASSOCIATED ASSET (E.G., A VEHICLE).

a) Postures 1–3 are already predefined. Use integer values 4–61 to define other nuclear postures.
b) See input manual for proper format of SHIELDING inputs.
c) See subroutine SHLDIN.

86) ** ERROR-86 ** ERROR IN SHIELD. CODE NUMBER ___ NOT ALLOWED.

a) See AURA Volume II for all currently allowable nuclear posture codes.
b) See input manual for proper format of SHIELDING inputs.
c) See subroutine SHLDIN.

87) ** ERROR-87 ** ERROR IN THERMAL (NUCLEAR) INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of THERMAL input in runstream.
d) See input manual for proper format.
e) See subroutine THRMIN.

88) ** ERROR-88 ** ERROR AFTER TIREDNESS CARD. ASSETS MUST BE PERSONNEL.

a) Check that asset name has been defined under ASSET card as personnel.
b) See subroutine TIREIN.

89) ** ERROR-89 ** ERROR IN TOXIC KILL CRITERIA INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of TOXIC KILL CRITERIA input in runstream.
d) See input manual for proper format.
e) See subroutine TKCIN.

90) ** ERROR-90 ** ERROR IN TOXIC LETHALITY INPUT. X, Y, AND T, (DOWNWIND, CROSSWIND, AND TIME) MUST BE INCREASING ARRAYS.

a) Check toxic lethality inputs in PRETOX output file. X, Y, and T must be increasing arrays.
b) May be an error in the toxic lethality file (TAPE 4).
c) See subroutine TOXIN.

91) ** ERROR-91 ** ERROR IN TOXIC LETHALITY INPUT. FAULTY CARD. [ ].

a) Check format and syntax of toxic lethality input in runstream on Unit No. 4.
b) See subroutine TOXIN.

92) ** ERROR-92 ** ERROR IN TRACE INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of TRACE LINK USAGE input in runstream.
d) See input manual for proper format.
e) See subroutine TRACIN.

93) ** ERROR-93 ** LINK ___ IS SIMULTANEOUSLY USED ____ TIMES IN CHAIN ___.

a) A link can only appear once in any given chain. Redefine functional structure.
b) See subroutine USDCHK.

94) ** ERROR-94 ** NUMBER OF EXPENDABLE ITEMS EXCEEDS MAX (@NXP). STOP IN XPNDIN.

a) Reduce the number of expendable items to less than maximum (@NXP).
b) See subroutine XPNDIN.

95) ** ERROR-95 ** ERROR IN EXPENDABLE INPUT. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format and syntax of EXPENDABLE input in runstream.
d) See input manual for proper format.
e) See subroutine XPNDIN.

96) ** ERROR-96 ** EXCEEDED MEMORY DURING INPUT DOSE-TIME PERFORMANCE DEGRADATION DATA.

a) Reduce the input data.
b) Redimension RA.
c) See subroutine IDPIN.

97) ** ERROR-97 ** ERROR IN DOSE BINS. BINS MUST INCREASE IN DOSE.

a) Values of the bins must be sequentially increasing.
b) See input manual for proper format of DOSE PARAMETERS inputs.
c) See subroutine BINSET.

98) ** ERROR-98 ** DOSE BINS MAY NOT EXCEED DOSMAX.

a) Dose bins may not exceed the maximum dosage.
b) Reduce dose bins or increment DOSMAX.
c) See subroutine BINSET.

99) ** ERROR-99 ** MUST INPUT LINKS BEFORE CHAINS.

a) Check input runstream for correct ordering of CHAINS and LINKS.
b) See subroutine CHNIN.

100) ** ERROR-100 ** DEPLOYMENT, WEAPON EFFECTS DELIVERY ERRORS AND TLE MUST PRECEDE ROUND AND VOLLEY, WHEN IN CULL MODE.

a) Check order of mnemonic cards.

b) See subroutine CONVIN.

101) ** ERROR-101 ** TOO MANY CREWS. MAX = (@NCR).

a) Maximum number of crews allowed is (@NCR). Reduce number of crews or redimension code.

b) See subroutine CRWIN.

102) ** ERROR-102 ** EXCEEDED STORAGE FOR CREW DATA.

a) Reduce number or size of crews or redimension code.

b) See subroutine CRWIN.

103) ** ERROR-103 ** CODE CURRENTLY DOES NOT ALLOW MIXING OF NUCLEAR AND CHEMICAL ATTACKS IN THE SAME ENCOUNTER.
STOP CALLED FROM EVNCHK.

a) AURA currently does not allow the modeling of both CHEMICAL and NUCLEAR attacks within the same encounter. Two separate runs must be made.

b) See subroutine EVNCHK.

104) ** ERROR-104 ** ERROR IN INTERNAL RECONSTITUTION INPUT. NUMBER OF TIMES MUST BE .GT. 0 AND .LT. 48.

a) INTERNAL RECONSTITUTION card must be followed by at least 1, but no more than 48, time values.

b) See subroutine INTNIN.

105) ** ERROR-105 ** ASSET ____ CANNOT SUBSTITUTE INTO LINK ___ AT .GT. 100%.

a) Maximum effectiveness of a link is 100%. Check input for possible typographical error.

b) See subroutine LNKCHK.

106) ** ERROR-106 ** MODE CARD WITH THE CULL OPTION MUST PRECEDE THE ROUND AND VOLLEY INPUT.

a) Cull option must be set before input of incoming rounds. Check order of VOLLEY/ROUND inputs in runstream.
b) See subroutine MODEIN.

107) ** ERROR-107 ** TOO MANY ORLINKS. MAX = (@ORL).

a) Reduce the number of orlinks to less than (@ORL) or redimension code.
b) Check ORLINKS input in runstream.
c) See subroutine ORLIN.

108) ** ERROR-108 ** MAXIMUM MOPP = ___. SOMEHOW, A MOPP LEVEL WAS DEFINED ABOVE THE ALLOWED, CHECK DEPLOYMENT, MOPP, TOXIC KILL CRITERIA OR REST INPUTS.

a) Reduce the number of MOPP postures to eight or less.
b) See subroutine PRECHK.

109) ** ERROR-109 ** TOO MANY SUBCHAINS. MAX = (@NSC).

a) Reduce the number of subchains to less than (@NSC) or redimension code.
b) See subroutine SBCIN.

110) ** ERROR-110 ** TOXIC WEAPON ____ DOES NOT HAVE A SHORT TIME VAPOR DOSAGE SPECIFIED. THINGS START HAPPENING BY ____.

a) Rerun NUSSE using an earlier time of interest close to but not greater than the time specified.
b) See subroutine TOXCHK.

111) ** ERROR-111 ** TIME INTERVAL BETWEEN LONGEST MOPP TIME AND DOSAGE UPDATE TIME FOR TOXIC WEAPON ___ IS LONG.

a) Compare maximum MOPP time to the output times used in the NUSSE model. Pick a NUSSE output time slightly greater than the maximum MOPP time.
b) May need to reset INTERNAL or RECONSTITUTION times to shorten this time interval.
c) See subroutine TOXCHK.

112) ** ERROR-112 ** NO TOXIC DISPERSION DATA FOR WEAPON ___.

a) Verify that weapon name in runstream and lethality file is the same.
b) See subroutine WEPCHK.

113) ** ERROR-113 ** ERROR IN TOXIC WEAPONS. WEAPONS THAT SHARE THE SAME TOXIC DISPERSION FILES, WERE NOT DECLARED TO BE THE SAME AGENT. FOUND IN WEPCHK.

a) Weapons sharing toxic dispersion file must be the same agent type. Redefine agent types under the AGENT mnemonic or input separate dispersion files.
b) See subroutine WEPCHK.

114) ** ERROR-114 ** ASSET ___ REQUIRES MORE THAN 27 REPAIR LINKS. ILLEGAL. STOP IN PRECHK.

a) Reduce the number of repair links required to repair the given asset.
b) See input manual for proper format of REPAIR inputs.
c) See subroutine PRECHK.

115) ** ERROR-115 ** ASSET___ WAS DEFINED AS PERSONNEL BUT WAS GIVEN REPAIR PARAMETERS. ILLEGAL.

a) Personnel cannot be repaired. Check inputs under REPAIR.

b) See subroutine RPRIN.

116) ** ERROR-116 ** FORMAT ERROR IN ACQUISITION PROBABILITY INPUT.
FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of ACQUISITION PROBABILITY input in runstream.

d) See input manual for proper format.

e) See subroutine ACQRIN.

117) ** ERROR-117 ** FORMAT ERROR IN TIME INPUT FOR CHAIN ___.
FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Must have even number of reals and no integers.

d) Check format and syntax of CHAIN input in runstream.

e) See input manual for proper format.

f) See subroutine CHNIN.

118) ** ERROR-118 ** FORMAT ERROR IN DEPLOYMENT OF TARGET NO._____.
FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of DEPLOYMENT input in runstream.

d) See input manual for proper format.

e) See subroutine DEPLIN.

119) ** ERROR-119 ** FORMAT ERROR ON FATIGUE INPUT FOR ____.

a) Check format of FATIGUE input in runstream.

c) See input manual for proper format.

b) See subroutine FATIN.

120) ** ERROR-120 ** FORMAT ERROR AFTER INCOMING CARD.

a) Check format and syntax of input after INCOMING FIRE DIRECTION mnemonic card in runstream.

b) See input manual for proper format.

c) See subroutine INCIN.

121) ** ERROR-121 ** FORMAT ERROR AFTER OFFSET CARD. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of input after OFFSET card in runstream.

d) See input manual for proper format.

e) See subroutine OFFSIN.

122) ** ERROR-122 ** FORMAT ERROR AFTER REINFORCEMENT/LOSSES CARD.
FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of input after REINFORCEMENT/LOSSES card in runstream.

d) See input manual for proper format.

e) See subroutine RENIN.

123) ** ERROR-123 ** FORMAT ERROR AFTER REPLICATIONS CARD.

a) Check format of input after REPLICATIONS card in runstream.

b) See input manual for proper format.

c) See subroutine REPLIN.

124) ** ERROR-124 ** FORMAT ERROR IN SHIELDING INPUT FOR ___.
FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format of SHIELDING input in runstream.
d) See input manual for proper format.
e) See subroutine SHLDIN.

125) ** ERROR-125 ** FORMAT ERROR IN TLE. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format of TLE input in runstream.
d) See input manual for proper format.
e) See subroutine TLEIN.

126) ** ERROR-126 ** FORMAT ERROR ON INPUT OF VOLLEY. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format of VOLLEY input in runstream.
d) See input manual for proper format.
e) See subroutine VLLYIN.

127) ** ERROR-127 ** FORMAT ERROR AFTER WIND DIRECTION CARD. FAULTY CARD.
[ ].

a) Line of input with error will be output in brackets.
b) See line of input where error occurred.
c) Check format of WIND DIRECTION input in runstream.

d) See input manual for proper format.

e) See subroutine WINDIN.

128) ** ERROR-128 ** FOUND AN ILLEGAL DEGRADATION CODE IN SUBROUTINE DGDSTM.

a) See SUBLETHAL DOSE DEGRADATION input in the input manual for correct format of code numbers.

b) See subroutine DGDSTM.

129) ** ERROR-129 ** INPUT ERROR, FAULTY CARD [ ] DETECTED ON INPUT OF DATA FOR WEAPON __ VS. TARGET___.

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check runstream for correct format and syntax under input data for specified weapon.

d) See subroutine CONVIN.

130) ** ERROR-130 ** INPUT ERROR AFTER CARD ___ ON OR BEFORE CARD ___.

a) Check format and syntax of input in runstream.

b) See subroutine ENCIN.

131) ** ERROR-131 ** INCORRECT NO. OF REAL NUMBERS ON FAILURE FOR ____.

a) Check for correct number of reals on FAILURE input.

b) See input manual for proper format.

c) See subroutine FAILIN.

132) ** ERROR-132 ** INPUT ERROR. FAULTY CARD. [ ].

a) Line of input with error will be output in brackets.

b) See line of input where error occurred.

c) Check format and syntax of input in runstream.
d) See input manual for proper format.
e) See subroutine NUCIN.

133) ** ERROR-133 ** LINK ____ IS NOT DEPLOYED. ASSETS IN LINK CANNOT TAKE CASUALITIES!!!

a) Location of link must be defined. Assets will fill into tasks, but kills against these assets cannot be assessed unless link is deployed.
b) Verify LINKS and DEPLOYMENT section of runstream.
c) See subroutine LNKCHK.

134) ** ERROR-134 ** LETHALITY DATA EXCEEDS STORAGE. STOP IN TOXIN.

a) Combine lethality data or redimension array RA.
b) See subroutine TOXIN.

135) ** ERROR-135 ** LETHALITY DATA TYPE 1 NOT ALLOWED, REQUESTED FOR WEAPON __ ON ASSET _____.

a) Data type one is currently not allowed. Change lethality input.
b) See AURA Volume I for currently available lethality data types.
c) See subroutine CONVIN.

136) ** ERROR-136 ** MAXIMUM NUMBER OF LINKS (@LNK) EXCEEDED.

a) Reduce number of links to less than (@LNK) or redimension code.
b) See subroutine DEPLIN.

137) ** ERROR-137 ** MUST INPUT KILL CRITERION FOR TARGET POINT.

a) Kill criteria can only be input as an integer with a value of 1–20. Check lethality file for appropriate level of kill criteria for target point and input on DEPLOYMENT card(s).

b) See subroutine DEPLIN.

138) ** ERROR-138 ** MUST INPUT LINKS BEFORE METABOLIC RATES.

a) Check order of input in runstream. Place links before metabolic rates.
b) Check link names and heat stress input for possible typographical error.
c) See subroutine HTSTIN.

139) ** ERROR-139 ** MUST START NAMES INPUT WITH WEAPON OR ASSETS CARD.

a) Check syntax of runstream. WEAPON or ASSET card must be the first non comment card after NAMES.
b) See input manual for proper format.
c) See subroutine NAMES.

140) ** ERROR-140 ** MUST INPUT LINKS BEFORE ORLINKS. STOP IN ORLIN.

a) Check order input in runstream. Place links before orlinks in runstream.
b) See subroutine ORLIN.

141) ** ERROR-141 ** NO CONVENTIONAL LETHALITY DATA FOR WEAPON NUMBER ___ ON ASSET ___ WITH COVER TYPE ___ AND KILL CRITERION ___.

a) Verify weapon name and check for missing lethality data. Also, verify posture types and kill criterion.
b) See subroutine CNVDMG.

142) ** ERROR-142 ** NUMBER OF COMPOUND LINKS EXCEEDS STORAGE.

a) Maximum number of compound links allowed is 21. Reduce the number of compound links or redimension code.
b) See subroutine CPLKIN.

143) ** ERROR-143 ** NUMBER OF SECONDARIES EXCEEDS STORAGE. STOP IN DEP2ND.

a) Maximum number of secondaries allowed is 103. Reduce the number of secondary explosions to less than 103 or redimension code.
b) See subroutine DEP2ND.

144) ** ERROR-144 ** NUMBER OF TARGET POINTS EXCEEDED WHILE EXTENDING FOR SECONDARY EXPLOSION SOURCES. STOP IN DEP2ND.

a) Reduce the number of target points, especially secondary explosives.
b) See subroutine DEP2ND.

145) ** ERROR-145 ** NUMBER OF RECONSTITUTIONS EXCEEDS STORAGE ____. MAX = (@TIM).

a) Reduce the number of reconstitutions times to less than (@TIM) or redimension code.
b) See subroutine EVNCHK.

146) ** ERROR-146 ** NUMBER OF POSSIBLE SURVIVORS BY TARGET POINT EXCEEDS STORAGE IN RA. STOP IN NDXSET.

a) Reduce the number of assets deployed or redimension #RA.
b) See subroutine NDXSET.

147) ** ERROR-147 ** NUCLEAR LETHALITY DATA HAS SUSPICIOUSLY LOW SIGMA FOR ASSET TYPE ______.

a) Nuclear lethality data sigma must be greater than 0.001.
b) Check nuclear vulnerability file.
c) See subroutine NUCIN.

148) ** ERROR-148 ** NUMBER OF WEAPONS HAVING COMMON NAME ____ EXCEEDS TEMPORARY STORAGE IN CONVIN.

a) Reduce number of weapons with common name or redimension code.

b) See subroutine CONVIN.

149) ** ERROR-149 ** NUMBER OF CONVENTIONAL LETHALITY TYPES EXCEEDS MAX (20).

a) Reduce the number of conventional lethality types to less than 20.

b) A conventional lethality type is defined by a weapon name in the conventional lethality data file. See Appendix B in AURA Volume 2.

c) See subroutine CONVIN.

150) ** ERROR-150 ** NUMBER OF PARAMETERS ___ NOT CORRECT FOR DATA TYPE _____. CONVENTIONAL LETHALITY DATA ERROR ON WEAPON __ VS. ID ___.

a) Check conventional lethality file for correct format and syntax of input data.

b) See subroutine CONVIN.

151) ** ERROR-151 ** NUMBER OF TARGETS EXCEEDS ALLOTTED STORAGE = ____.

a) Reduce number of targets or redimension code.

b) See subroutine DEPLIN.

152) ** ERROR-152 ** NUMBER OF EVENTS EXCEED STORAGE _____. STOP IN EVNTBL. MAX = (@NEV).

a) Reduce the number of events allowed to less than (@NEV) or redimension code.

b) See subroutine EVNTBL.

153) ** ERROR-153 ** NUMBER OF TOXIC ROUNDS AWAITING PROCESSING ____ EXCEEDS STORAGE. STOP IN LETHAL.

a) Reduce the number of chemical rounds or spread them out in time or redimension code.

b) See subroutine LETHAL.

154) ** ERROR-154 ** NUMBER OF LINKS EXCEEDS MAX ____. STOP IN LNKIN.

a) Reduce the number of links to less than (@LNK) or redimension code.

b) See subroutine LNKIN.

155) ** ERROR-155 ** NUMBER OF PARAMETERS ___ NOT CORRECT FOR DATA TYPE ____. NUCLEAR VULNERABILITY ERROR FOR ASSET ___.

a) Check syntax for nuclear vulnerability input.

b) See subroutine NUCIN.

156) ** ERROR-156 ** NUMBER OF TOXIC WEAPON TYPES EXCEEDS STORAGE. MAX = (@TW).

a) Reduce the number of toxic weapon types to less than (@TW) or redimension code.

b) See subroutine TOXIN.

157) ** ERROR-157 ** NUMBER OF VOLLEYS EXCEEDS STORAGE. STOP CALLED FROM VOLLEY.

a) Reduce the number of volleys or redimension code.

b) See subroutine VLLYIN.

158) ** ERROR-158 ** ONLY @NAP TLE CHANGES ALLOWED. STOP IN TLE INPUT.

a) Reduce the number of target location error change events to less than (@NAP) or redimension code.

b) See subroutine TLEIN.

159) ** ERROR-159 ** PROBABLE ERROR IN LINK INPUT. NAME _____ BEGINS WITH A SPECIAL CHARACTER (=,*,+,!).

a) Verify syntax of link input in runstream. Possible typo.
b) Link name may not begin with special character.
c) See subroutine LNKIN.

160) ** ERROR-160 ** NUMBER OF SUBSTITUTES EXCEEDS STORAGE _____. MAX = (@NSB). STOP CALLED FROM ENCSET.

a) Reduce the number of substitutes to less than (@NSB) or redimension code.
b) See subroutine ENCSET.

161) ** ERROR-161 ** REPAIR DATA MUST BE INCLUSIVE! STOP IN LETHAL.

a) Probability of light damage > medium damage > heavy damage for all miss distances.
b) See AURA Volume 1.
c) See subroutine CNVLTH.

162) ** ERROR-162 ** SECONDARY EXPLOSION ASSET MUST BE NAMED IN BOTH ASSET AND WEAPON INPUTS.

a) Check ASSET and WEAPON cards for secondary explosion name. Primary name of secondary explosive must appear under both.
b) See subroutine SCNDIN.

163) ** ERROR-163 ** SOMETHING WRONG IN REPAIR. CLEAR BEFORE OPTMIZ DIAGNOSTIC. STOP IN OPTMIZ.

a) Internal code error. Contact Code Custodian.
b) See subroutine OPTMIZ.

164) ** ERROR-164 ** SORRY! TOXIC DISSEMINATION DATA MUST BE READ IN BEFORE ALARMS. THE CODE FOUND NO VAPOR NORMALIZATION FOR WEAPON _____.

a) Check that toxic dissemination data was input correctly and was listed in runstream before the ALARM mnemonic card.
b) See subroutine ALRMIN.

165) ** ERROR-165 ** STORAGE EXCEEDED FOR CHAINS. STOP IN CHAIN INPUT ROUTINE.

a) Maximum number of chains allowed is six. Reduce number of chains or redimension code.
b) See subroutine CHNIN.

166) ** ERROR-166 ** STORAGE (@RA) EXCEEDED IN LARGE MASTER ARRAY.

a) Reduce conventional lethality data.
b) Redimension code.
c) See subroutine CONVIN.

167) ** ERROR-167 ** STORAGE FOR COMPOUND LINK PARTS _____ EXCEEDED. MAX = (@NCP).

a) Reduce the number of compound link parts to less than (@NCP) or redimension code.
b) See subroutine CPLKIN.

168) ** ERROR-168 ** STORAGE FOR SUBSTITUTES EXCEEDED. REDIMENSION RA AND MDX(3) (MD3). STOP IN ENCSET.

a) Reduce the number of substitutes or redimension code.
b) See subroutine LNKSET.

169) ** ERROR-169 ** STORAGE EXCEEDED FOR ORLINKS. STOP IN ORLINK INPUT ROUTINE.

a) Reduce the number of orlinks to less than (@ORL) or redimension code.
b) See subroutine ORLIN.

170) ** ERROR-170 ** STORAGE EXCEEDED FOR SUBCHAINS. STOP IN SUBCHAIN INPUT ROUTINE.

a) Reduce the number of subchains to less than (@SCH) or redimension code.
b) See subroutine SBCIN.

171) ** ERROR-171 ** SUBCHAIN ___ , EXCEEDS MAXIMUM LINKS (__). USE MORE SUBCHAINS OR REDIMENSION TEMPORARY STORAGE IN SBCOPT.

a) Only 27 links allowed in any one subchain.
b) Change structure or redimension SBCOPT and SBCIN.
c) See subroutine SBCIN.

172) ** ERROR-172 ** TEMPORARY STORAGE FOR SEGMENTS (__) EXCEEDED IN OPTMIZ NEED FOR CHAIN REPAIR LINKS.

a) Reduce number of segments in chain to less than 94 or redimension code.
b) See subroutine OPTMIZ.

173) ** ERROR-173 ** TOO MANY ASSETS IDENTIFIED AS ALARMS (5 MAX).

a) Reduce number of unique assets identified as alarms to five or less.
b) Redimension code.
c) See subroutine ALRMIN.

174) ** ERROR-174 ** TOO MANY TIME INTERVALS FOR CHAIN ____.

a) Reduce the number of time intervals to less than 17 or redimension code.
b) See subroutine CHNIN.

175) ** ERROR-175 ** TOO MANY DELIVERY ERROR EVENTS.

a) Reduce the number of delivery errors to less than 193 or redimension code.
b) See subroutine DLVRIN.

176) ** ERROR-176 ** TOO MANY INCOMING FIRE DIRECTION CHANGES. STOP IN INCIN.

a) Reduce the number of incoming fire directions to less than 21 or redimension code.
b) See subroutine INCIN.

177) ** ERROR-177 ** TOO MANY ALARMS DEPLOYED. MAX = (@NAR). STOP IN TGTSET.

a) Reduce the number of alarms to less than (@NAR) or redimension code.
b) See subroutine TGTSET.

178) ** ERROR-178 ** TOP OF MEMORY (ARRAY RA) EXCEEDED BY EXPANDING DOSE BINS. STOP IN ROUTINE CUMDOS. MAY SOLVE PROBLEM BY TURNING INDIVIDUAL DOSE OFF (UNDER MODE).

a) Try turning INDIVIDUAL DOSE off (under MODE mnemonic card). If this does not work, contact Code Custodian.
b) Redimension code.
c) See subroutine CUMDOS.

179) ** ERROR-179 ** TROUBLE. NUCLEAR LETHALITY DATA OVERFLOWS TOP OF MEMORY. STOP IN NUCIN.

a) Reduce amount of input data (size of unit, etc.).

b) Redimension code.

c) See subroutine NUCIN.

180) ** ERROR-180 ** WEAPON NAME DOES NOT APPEAR ON WEAPON NAME LIST.

a) Check for typo in weapon name list and weapon characteristic inputs.

b) See subroutine DLVRIN.

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